KENWORTH CLEAN POWER™ SYSTEM

Storage Cooler
Service Manual

- Improper installation or repair of auxiliary heating and cooling systems can cause fire or the leakage of deadly carbon monoxide leading to serious injury or death.
- Installation and repair of auxiliary heating and cooling systems requires special training, technical information, special tools and special equipment.
- NEVER attempt to install or repair an auxiliary heating or cooling system unless you have successfully completed the factory training course and have the technical skills, technical information, tools and equipment required to properly complete the necessary procedures.
- ALWAYS carefully follow the installation and repair instructions and heed all WARNINGS.
- The manufacture rejects any liability for problems and damage caused by auxiliary systems being installed or serviced by untrained personnel.

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1. Introduction

1.1 The Kenworth Clean Power System

The Kenworth Clean Power System is a battery-powered sleeper climate control system with the capability to provide engine-off heating and cooling, plus 120-Volt AC accessory power to drivers for up to 10 hours. To recharge the cooling and electrical capacity, the truck must be driven or connected to shore power.

The Kenworth Clean Power System sleeper heating and air conditioning system is an independent system from the cab heating and air conditioning system. Both the controls and the heating and cooling sources are different.

Kenworth Clean Power System features include:

- Compliance with all state and federal anti-idling regulations.
- Engine-off sleeper heating, cooling, and 120-Volt AC power.
- No engine noise or vibration.
- Improved fuel economy.

All information contained in this manual is based on the latest production information available at the time of publication. Kenworth Truck Company reserves the right to make changes at any time without notice.

1.2 Location of Components

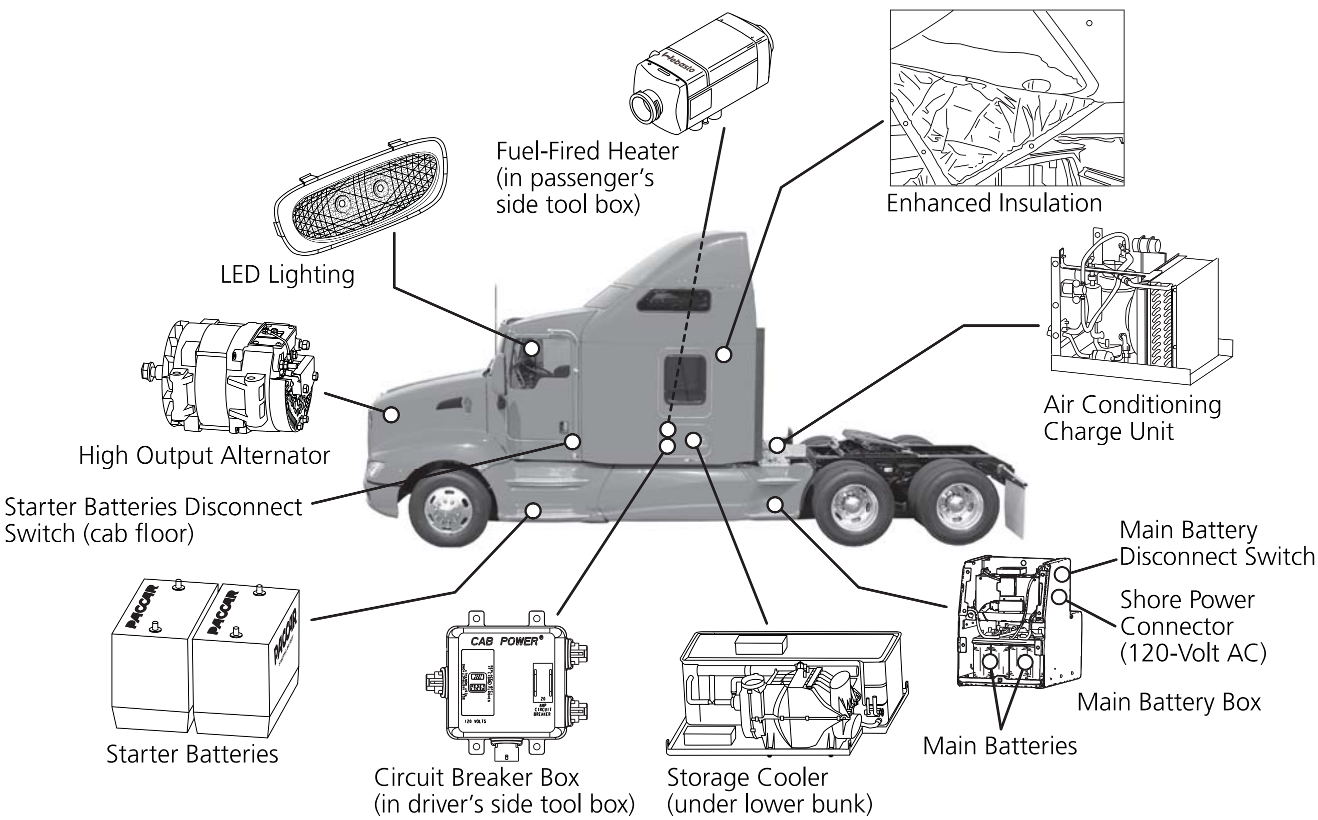


Figure 1. Location of components

1.3 Safety Signals

A number of alerting messages are in this manual. Please read and follow them. They are there for your protection and information. These messages can help you avoid injury to yourself and your passengers, and help prevent costly damage to the vehicle.

Key symbols and "signal words" are used to indicate what kind of message is going to follow. Pay special attention to instructions prefaced by symbols and signal words "WARNING," "CAUTION," or "NOTE." Please do not ignore any of these alerts.

WARNING

When you see this symbol and word, the message that follows is especially vital. This signals something that can cause injury or even death. This message will tell you what the hazard is, what can happen if you don't heed the warning, and how to avoid it.

Example:

WARNING. Risk of asphyxiation. The auxiliary heater must not be operated in enclosed areas such as garages and workshops without an emissions extraction system.

CAUTION

This symbol and word signals something that could damage the vehicle or equipment.

Example:

CAUTION: A temperature of 85°C must not be exceeded in the vicinity of the auxiliary heater in any circumstances (for example when completing painting work on the vehicle).

NOTE

Gives you information we feel you would like to have. It could have to do with procedures and tips that will help you work more efficiently.

Example:

NOTE: The connector housing can be locked (self-locking action) by simply pulling on the wiring harness.

1.4 Recommended Service Tools

- AC Recovery / Charging Machine - Must be R134a compliant.
- R134a Leak Detector - Must be R134a compliant.
- Dry Nitrogen Gas (Bottled) with Regulator and Safety Relief Device - for Pressure Tests
- Digital Multi-Meter - Should be a good quality VAO meter.
- Temperature Probe or Thermometer
- Basic Mechanic's Tools

1.5 Electrical Tests - Prior to Troubleshooting and Servicing

Proper troubleshooting cannot be performed on an electrically weak system. As a minimum, inspect or perform the following:

- Cleaning of battery connections
- Cleaning of jumpers (bottom of connector typical weak connection point)
- Cleaning of cable connections at starter and DC generator (alternator)
- Cleaning ground connections at frame rails and other points of contact
- Load testing of batteries

1.6 Electrical Tests - After Servicing or Repairs

Ensure batteries are fully charged prior to operating the Kenworth Clean Power System. Batteries may have become significantly discharged due to interior lights on while working in the bunk or due to parasitic loss from live accessories.

1.7 Servicing the Refrigerant Circuit

NOTE: Please read before opening the refrigerant circuit for repairs or service.

It is recommended that the cold storage core be completely discharged (brought up to room temperature) before recovering the refrigerant. Otherwise, the system will have to be evacuated for a period not less than 2 hours to ensure any liquid refrigerant lingering in the storage core is boiled off.

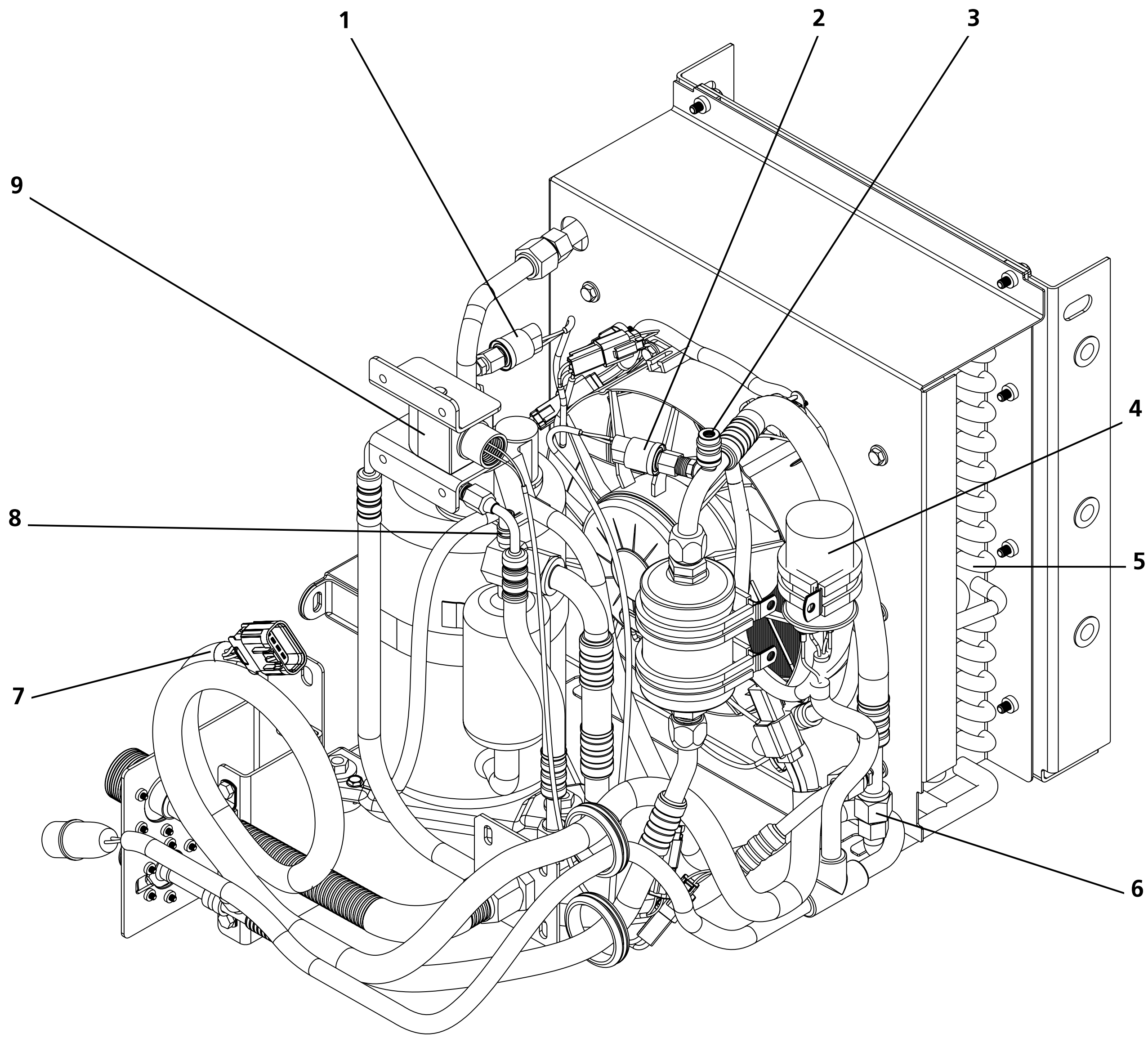
Servicing a charged (frozen) or partially charged (cold) system will give you inaccurate or false pressure readings.

2. General Description

The storage cooler portion of the Kenworth Clean Power™ System is based on the principles of refrigeration and the simple storage of cold energy.

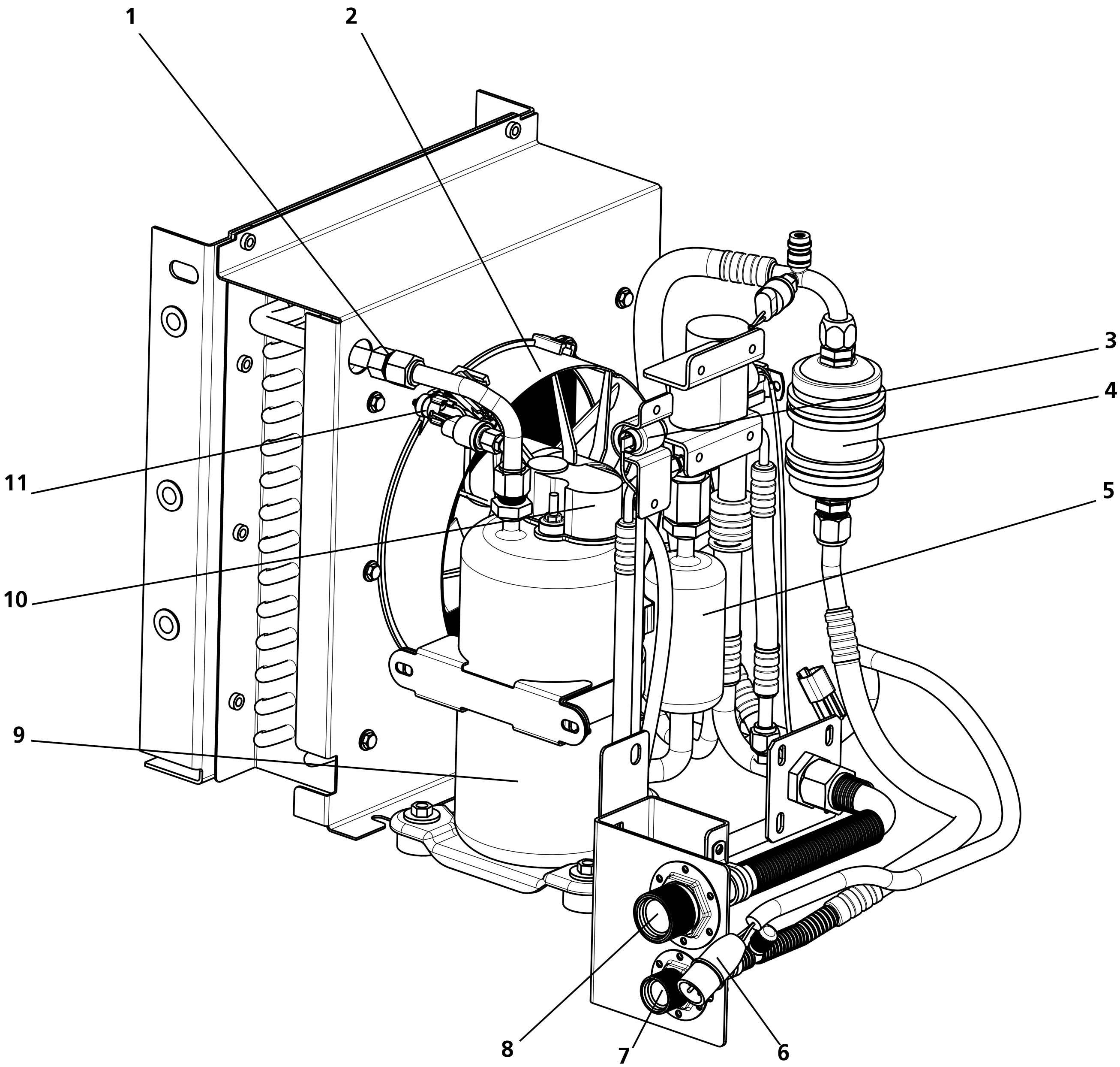
The storage cooler essentially consists of the following:

– a refrigeration “Charging unit” assembly
– a cold “Storage Cooler” assembly
– an air-handler assembly
– a cold transfer system (automotive anti-freeze mixture and R134a refrigerant)
– a 120 VAC power source to drive the compressor
– a 12 VDC power source



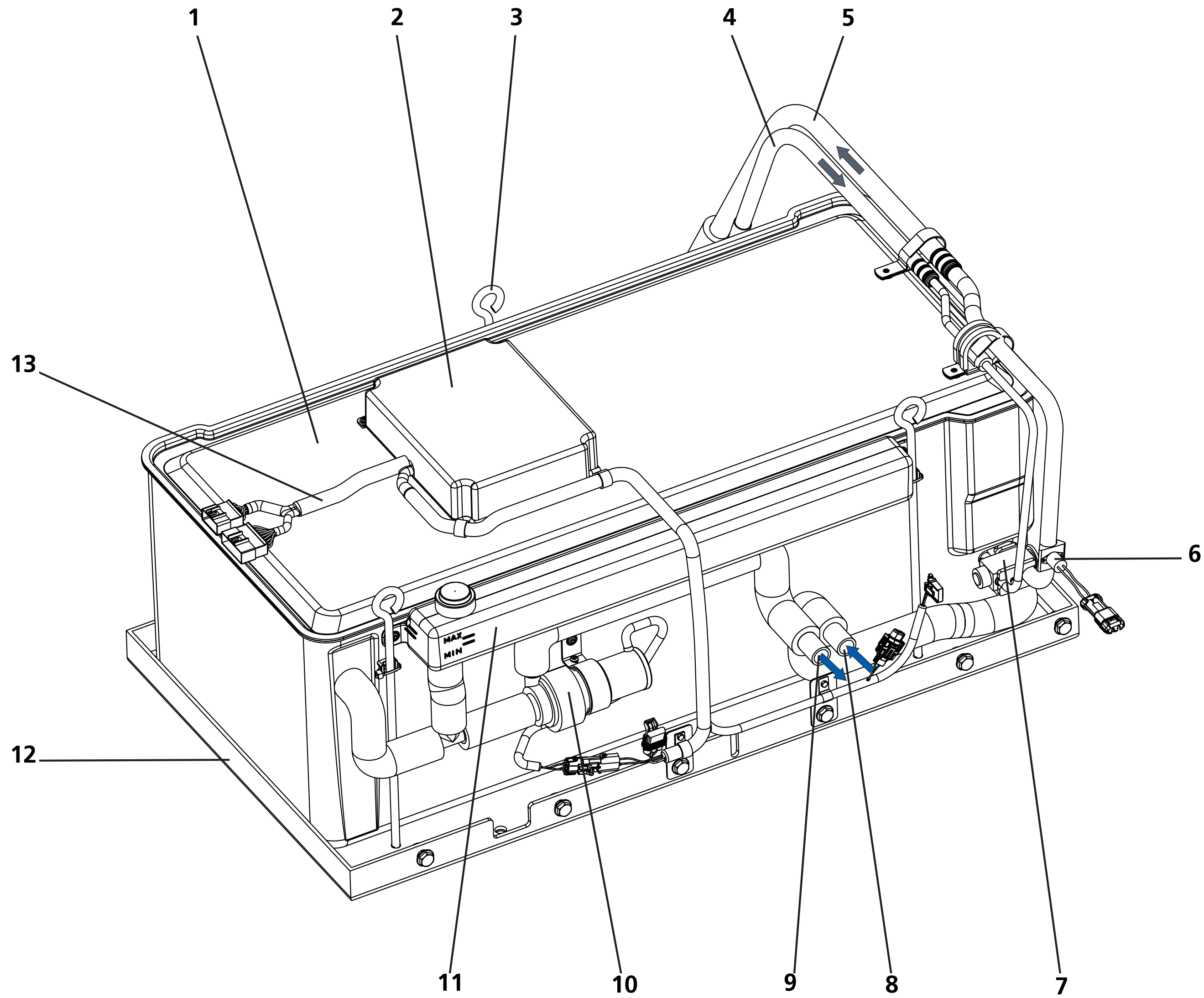
1. High refrigerant pressure switch
2. Low refrigerant pressure switch
3. Service port - High pressure liquid side
4. Run capacitor
5. Condenser
6. Condenser outlet connection
7. 12 Volt wiring harness and connector
8. Service port - low pressure gas side
9. Magnetic equalization (bypass) valve

Figure 2. Charging Unit - Overview 1 (Sheet metal removed for purpose of illustration)



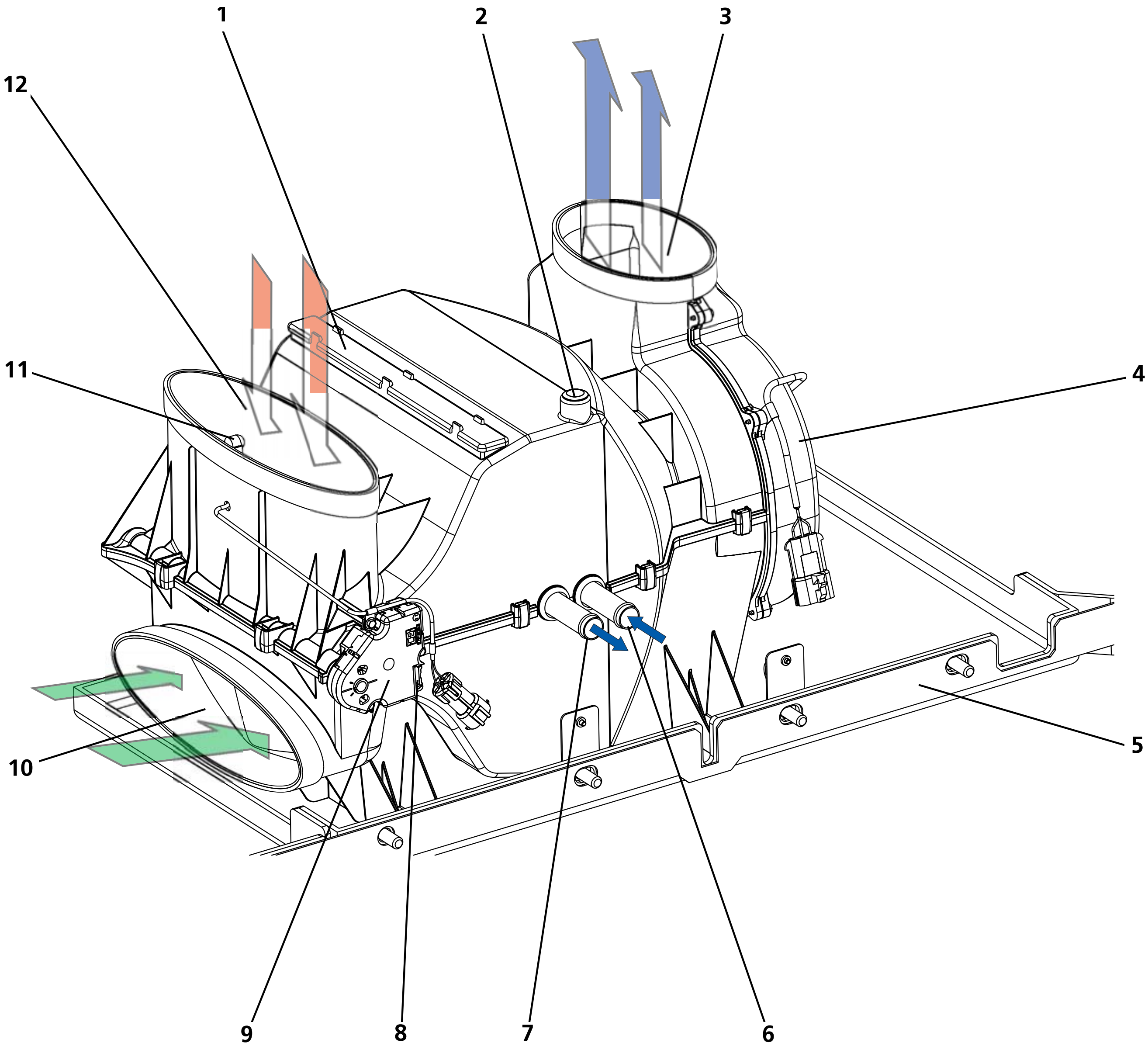
1. Condenser inlet connection
2. Condenser fan - Radial
3. Positive Temperature Coefficient Resistor (PTCR)-compressor hard-starting aid
4. Refrigerant filter/dryer
5. Accumulator
6. 120 VAC power connection
7. Refrigerant supply line to TXV and evaporator
8. Refrigerant return line from TXV and evaporator
9. Hermetic compressor for R134a refrigerant system
10. Cover for electrical connections and thermal/overload protector
11. Ambient temperature limiter

Figure 3. Charging Unit - Overview 2 (Sheet metal removed for purpose of illustration)



1. Storage cooler assembly
2. Storage Cooler Control Unit (SCCU)
3. Lifting bolt - 3 total
4. Refrigerant supply line from charging unit
5. Refrigerant return line to charging unit
6. Temperature control thermostat
7. Thermal expansion valve (TXV)
8. Coolant return line from air handler
9. Coolant supply line to air handler
10. Coolant circulating pump (AC Pump)
11. Coolant reservoir with filler cap
12. Large pallet (Base)
13. Control and power harness with connectors SCCU-1 and SCCU-2

Figure 4. Storage Cooler Assembly



1. Cover - Air filter housing and filter
2. Port - Access to heat-exchanger bleeder valve
3. Conditioned air outlet
4. Fan and scroll housing
5. Small pallet (Base)
6. Coolant inlet from storage cooler assembly
7. Coolant outlet to storage cooler assembly
8. Connection Socket - Mode door actuator
9. Motor - Mode door actuator (Fresh/Recirculated)
10. Fresh air inlet
11. Cabin temperature sensor (Recirculated air mode)
12. Recirculated air inlet (Interior return)

Figure 5. Air Handler Assembly

2.1 Charging (Refrigeration) Unit

The charging unit is comprised of an electric refrigeration compressor, a condenser core with an electric automotive type radial fan, a pressure equalization valve, refrigerant lines, electrical circuitry and components.

See Fig. 2 and Fig. 3 for reference.

2.2 Storage Cooler Assembly

The storage cooler assembly is comprised of multiple layers of a freeze medium in the form of a vacuum sealed, water saturated, patented graphite matrix which is interlaced with a refrigeration evaporator core and a coolant circulation core.

The entire storage unit is encapsulated in urethane foam insulation and protected in a molded plastic housing. There are no serviceable items inside.

Externally, a thermal expansion valve, refrigerant lines, coolant lines, reservoir, coolant pump and a storage cooler control unit (SCCU) with accompanying circuitry make up the remaining serviceable components of the storage cooler assembly.

See Fig. 4 for reference.

2.3 Air-handler Assembly

The air-handler assembly is mounted under the sleeper bunk in the central compartment with the storage unit.

The air-handler is comprised of a liquid to air heat exchanger, a low power consumption, air circulation fan, a fresh air intake and a recirculated air intake duct. A motor actuated fresh air/recirc. mode door is built into the plenum.

Fresh air, when desired, is drawn in from an opening in the lower rear sleeper panel. A replaceable Hepa air filter cartridge is also provided for improved air quality.

An opening in the bottom of the air handler housing and the vehicle floor allows for condensation to drain.

See Fig. 5 for reference.

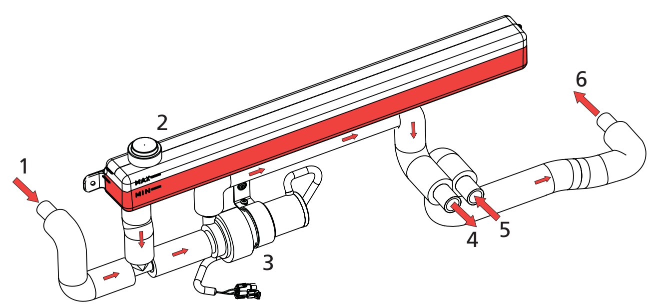
2.4 Cold Transfer System (Coolant Circuit)

The cold transfer system is comprised of a circulating pump, coolant hoses, coolant reservoir and a transfer medium of 50/50 premixed extended service glycol antifreeze and water mixture.

The system is active during system discharge. The temperature control knob of the sleeper control panel is used to adjust bunk temperature.

A sensor mounted in the recirculated air duct monitors the return air temperature in the sleeper. The A/C pump is thus switched on and off to circulate coolant through the air handler according to the desired cooling.

See Fig. 4 and Fig. 6 for reference.



1 Supply from storage cooler assembly
2 Coolant reservoir
3 A/C circulating pump 12 Volt
4 Inlet to air handler
5 Return from air handler
6 Return to storage cooler assembly

Figure 6. Coolant Circuit

To control and monitor the storage cooler system, it uses

- a Storage Cooler Control Unit (SCCU)
- a temperature control thermostat
- an ambient temperature limiter
- a high refrigerant pressure switch
- a low refrigerant pressure switch
- a charge enable switch located on the dash (Fig. 13)
- a system control panel located in the sleeper (Fig. 12)

To prevent serious damage to the compressor, a compressor overheat/overload protector is also provided.

2.5 Storage Cooler Control Unit (SCCU)

Situated on top of the storage unit, the SCCU is central to ensuring the correct function of the storage cooler portion of the Kenworth Clean Power™ System.

See Fig. 4 and Fig. 7 for reference.

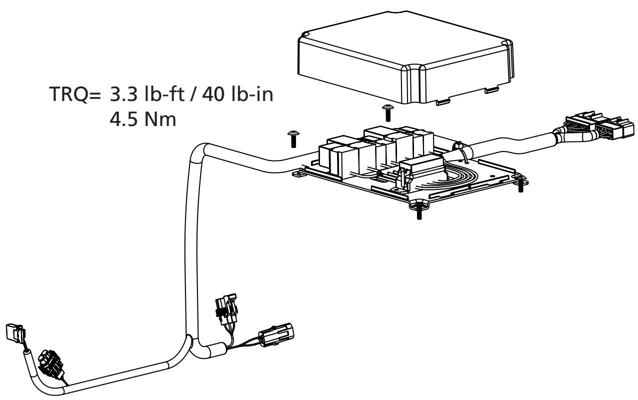


Figure 7. Storage Cooler Control Unit (SCCU)

2.6 Temperature Control Thermostat

A bi-metal temperature control thermostat is mounted on the refrigerant suction line as shown in Fig. 8.

The control thermostat will allow system charging or no system charging dependant on the storage core temperature at the suction line.

Switch Points – Temperature Control Thermostat

Opens at: -3.3°C (Tolerance of + 3°C, - 2°C)
26.1°F (Tolerance of + 5.4°F, - 3.6°F)

Closes at: 13.6°C
56.5°F

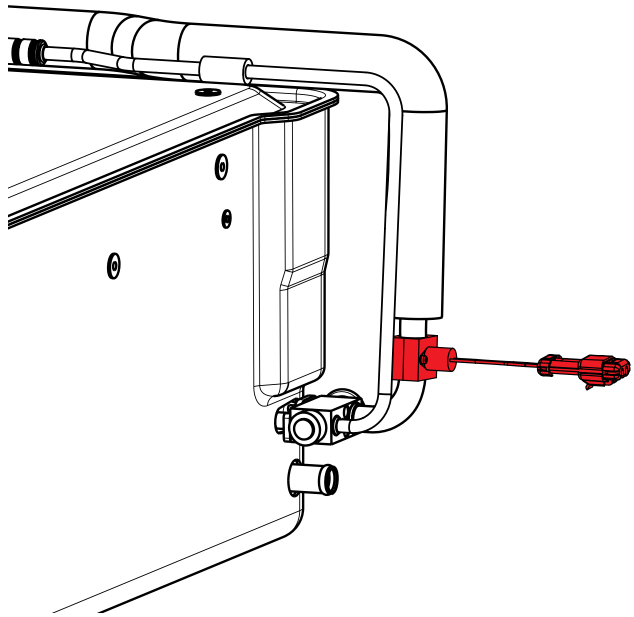


Figure 8. Temperature Control Thermostat

2.7 Ambient Temperature Limiter

A bi-metal ambient temperature limiter, located on the condenser fan shroud, is provided for the purpose of deactivating the bunk cooling system during cold weather periods when bunk cooling is not required.

See Fig. 3 and Fig. 9 for reference.

Switch Points – Ambient Temperature Limiter

Closes at: ≥ 12.8°C (Tolerance of ± 3.3°C)
≥ 55°F (Tolerance of ± 6°F)

Opens at: 7.2°C
45°F

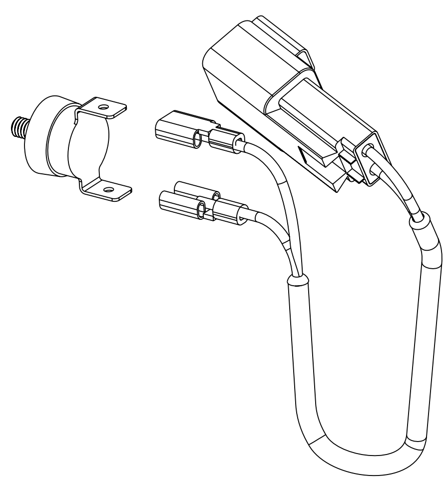


Figure 9. Ambient Temperature Limiter - with Harness

2.8 High Refrigerant Pressure Switch

Located in the high-pressure line before the condenser, the high refrigerant pressure switch will deactivate the compressor in the event of high pressure.

See Fig. 2 for a location reference and Fig. 10 for an illustration.

Switch Points (High Pressure Switch)

Opens at:	20.68 bar (Tolerance of ± 0.69 bar) 300 psig (Tolerance of ±10 psig)
Closes at:	12.4 bar 180 psig

2.9 Low Refrigerant Pressure Switch

Located in the high-pressure line after the condenser, the low refrigerant pressure switch will deactivate the compressor in the event of low pressure due to a loss of refrigerant.

See Fig. 2 for a location reference and Fig. 10 for an illustration.

Switch Points (Low Pressure Switch)

Opens at:	1.03 bar (Tolerance of ± 0.24 bar) 15 psig (Tolerance of ± 3 psig)
Closes at:	2.13 bar 31 psig

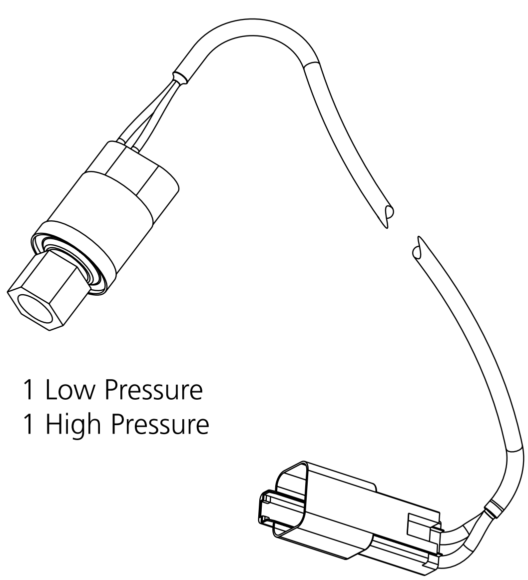


Figure 10. High pressure and low pressure switches

2.10 External Thermal Protector – Hermetic Compressor Motor

WARNING! 120 VAC Device. Lethal current may be present. Switch off the DC to AC power inverter before servicing.

The compressor motor is protected from overheating by a thermal protector mounted on top and in firm contact with the compressor housing. The thermal protector device quickly senses any unusual temperature rise or excess current draw.

The bi-metal disc within the thermal protector reacts to either excess temperature and/or excess current draw by flexing downward, and disconnecting the compressor from the power source.

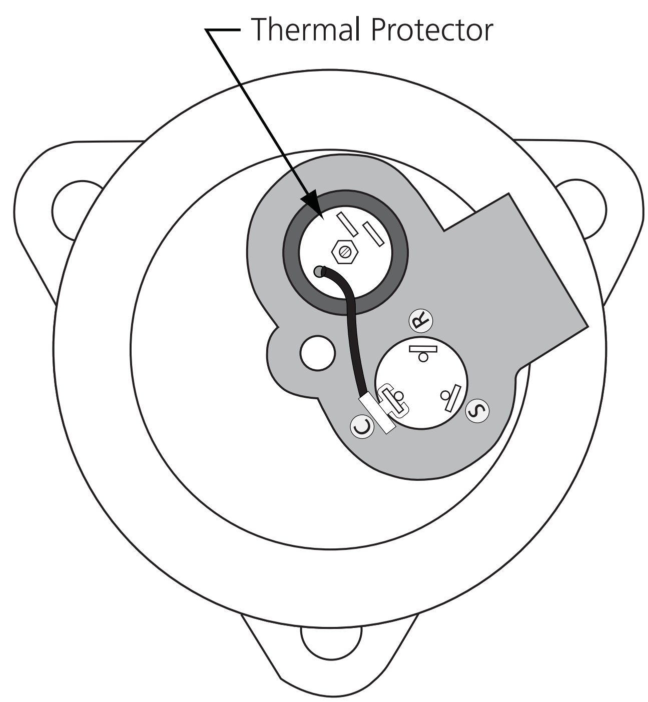
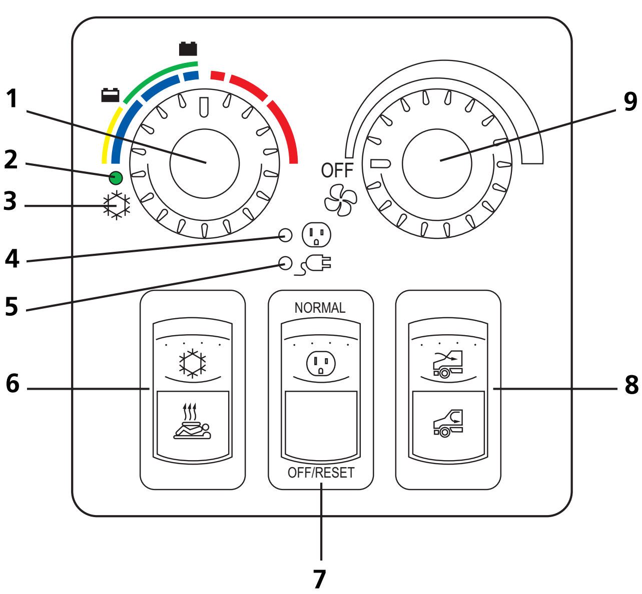


Figure 11. Hermetic Compressor - Thermal Protection

2.11 Sleeper Control Panel

Please refer to the "Kenworth Clean Power™ System Operator's Manual" for a complete description of functions and operating instructions.



1. Temperature Control Dial
2. AC Circulation Pump ON Lamp
3. Green Snowflake
4. Inverter/Charger Lamp
5. Shore Power Lamp (120 VAC)
6. Air Conditioning/ Heating Switch
7. Inverter/Charger Switch
8. Fresh Air/Recirculated Air Switch
9. Fan Control Dial

Figure 12. Kenworth Clean Power™ System Control Panel

2.12 Charge Enable Switch

Please refer to the "Kenworth Clean Power™ System Operator's Manual" for a description of function.

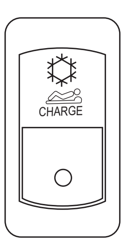


Figure 13. Charge Enable Switch (Located on dash)

2.13 Main Battery Box

The electrical power required to operate the Kenworth Clean Power™ System is supplied by a main battery box consisting of four deep-cycle batteries, and a power inverter to supply 120 VAC to the refrigerant compressor. The main battery box is also equipped with a shore power connection and a battery charger for stand-alone, engine off operation.

NOTE: Information about maintenance and servicing of the main battery box is not covered in this manual. For information concerning the main battery box, please refer to the applicable documentation supplied by the manufacturer of this equipment.

[Click here for more information]

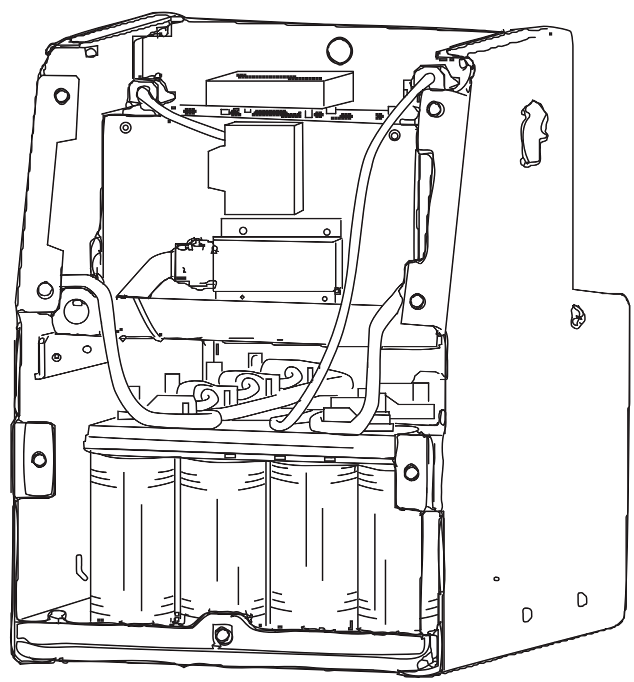


Figure 14. Main Battery Box

Manufactured by DYNACRAFT®
A division of PACCAR

3. Functional Description

3.1 Charging Under Inverter Power

With the vehicle engine running and the charging unit under inverter power only, the voltage regulator for the vehicle alternator determines whether or not the batteries have an acceptable charge.
The voltage regulator will transition through several stages of battery charging, with the first is known as bulk charging. The regulator ramps up the alternator to provide maximum current and will charge the batteries at 14.6V. The regulator also monitors the battery temperature and battery voltage to determine the charging rate that the batteries are accepting. Bulk charging lasts a minimum of 30 minutes. Once bulk charging is complete, the regulator ramps the current and voltage down, and closes the ground circuit through relay K9, pin-2 which then closes the relay and allows the compressor to start when all other conditions are satisfied (See Section 3.3).

3.2 Charging Under Shore Power

With the Clean Power system in shore power mode (shore power plugged into 120 VAC source) a signal is sent to relay K10, pin-1 which then closes the relay and starts the compressor. There is no delay of operation when in the shore power mode due to the fact that the system is receiving its power from an external 120 VAC source. In this case, the inverter is bypassed altogether.

3.3 Charging Mode

3.3.1 Charging (Reference Charge State Diagram in Fig. 15)

3.3.1.1 Charging Conditions

3.3.1.1.1 The charging unit automatically charges the storage cooler assembly when all of the following criteria are satisfied:

- Charge enable switch located on dashboard is switched ON
- Storage core temperature > -3.3°C + 3°C, - 2°C (26.1°F + 5.4°F, - 3.6°F)
- Ambient temperature > 12.8°C ± 3.3°C (55°F ± 6°F)
- High refrigerant pressure < 20.68 bar ± 0.69 bar (300 psig ± 10 psig)
- Low refrigerant pressure > 1.03 bar ± 0.24 bar (15 psig ± 3 psig)
- Battery voltage at acceptable level as determined by voltage regulator when engine is running OR shore power is connected
- Inverter AC voltage present

3.3.1.1.2 Once the criteria outlined in Section 3.3.1.1.1 are met, the charging process starts. First, the compressor bypass solenoid valve opens for approximately two minutes. This allows the pressures in the high and low sides of the refrigerant system to equalize. At this same time the condenser fan will also turn on. After approximately two minutes, the bypass solenoid valve closes and the compressor starts operation.

3.3.1.1.3 The charging unit automatically stops charging the storage cooler assembly if any of the following conditions are satisfied:

- AC enable switch located on dashboard is switched OFF
- Storage core temperature -3.3°C + 3°C, - 2°C (26.1°F + 5.4°F, - 3.6°F)
- Ambient temperature 12.8°C ± 3.3°C (55°F ± 6°F)
- High refrigerant pressure 20.68 bar ± 0.69 bar (300 psig ± 10 psig)

- Low refrigerant pressure 1.03 bar ± 0.24 bar (15 psig ± 3 psig)
- The voltage regulator determines that the batteries or alternator are not operating at acceptable levels when the engine is running OR when shore power is being used, shore power is disconnected
- Inverter AC voltage not present

3.3.1.2 Charging Enable/Disable Control

3.3.1.2.1 A charge enable/disable switch mounted on the vehicle dashboard is used for manually enabling/disabling the charging unit for charging the storage cooler assembly. When the switch is in the ON position, the charging unit is enabled and automatic charging of the storage cooler assembly occurs if the conditions of Section 3.3.1.1.1 are satisfied. When the switch is in the OFF position, the charging unit is disabled.

3.3.1.2.2 The switch contains one LED indicator which illuminate green when the charging unit is charging the storage cooler assembly (see Section 3.3.1.1.1 for charging conditions). This LED indicator will be illuminated only while the compressor is powered on and running.

3.3.1.2.3 The LED indicator turns off when the charging unit stops charging the storage cooler assembly (see Section 3.3.1.1.3 for stop charging conditions).

Approximate time to completely charge (freeze) the storage core is approximately 6 hours depending on the ambient temperature.

3.4 Discharge Mode

3.4.1 Discharging (Reference Fresh Air and Recirculation State Diagram, Fig. 16 and Cooling Discharge State Diagram, Fig. 17.)

3.4.1.1 Discharging Modes & Conditions

3.4.1.1.1 A linear voltage blower control is used for air conditioning and ventilation. The blower control is manually operated. NOTE: This blower control does not operate the heater blower since the heater blower is internal to the diesel-fired air heater.

3.4.1.1.2 The maximum blower power draw is set not to exceed 5 amps.

3.4.1.1.3 Blower speed is controlled with a potentiometer knob (S3). When the knob is in the off position, there is no electrical load (including the blower fan and circulating pump).

3.4.1.1.4 Blower control is available when the storage cooler thermostat (TC1) is in the off position for ventilation purposes.

3.4.1.1.5 The fresh air/recirc mode has two settings: fresh air and recirculating (no blending of the two). The fresh air/recirc mode is manually operated via a two-way switch (S5) on the control panel.

3.4.1.1.6 The temperature control is a closed loop which allows for setting the temperature at a comfortable level.

3.4.1.1.7 Temperature is controlled by a dual potentiometer. One potentiometer controls air conditioning temperature and the other potentiometer controls heating temperature. The required resistance values for the potentiometers are:

- Air Conditioning
  Minimum: +20°C = 1000Ω
  Maximum: +26°C = 460Ω
- Heating
  Minimum: +5°C = 150Ω
  Maximum: +35°C = 2150Ω

For both air conditioning and heating, resistance versus temperature has a linear relation, i.e., middle of temperature range correlates with middle of resistance range.

3.4.1.1.8 For each change in knob position, the temperature increases or decreases in equal amounts throughout the full range of motion for air conditioning and heating.

3.4.1.1.9 A return air temperature sensor is located in the air handling unit which will control when the storage cooler assembly's circulating pump turns on and off.

3.4.1.1.10 A green LED light is used on the control panel for indicating when the storage cooler assembly circulating pump is running.

3.4.1.1.11 A green/yellow band shown on the control panel above the blue temperature band indicates that when the temperature control is set in the green region of this band, a temperature of 23.9°C (75°F) can be maintained for 8-10 hours of storage cooler duration under the following conditions:

- Outside ambient temperature = 35°C (95°F)
- Sleeper pre-cooled to 23.9°C (75°F)
- Relative humidity = 50%
- No solar loading – e.g. truck parked in a shaded area or run system during the evening
- Airflow to lower and upper bunks
- Recirculated air mode

3.4.1.1.12 A 3-way switch on the control panel is provided for selecting air conditioning mode (top position), heating mode (bottom position), or off mode (middle position). When the switch is set to the off mode, all loads will be off except for those required for the blower and fresh/recirc actuator.

3.4.1.1.13 The 3-way air conditioning/heating selection switch is backlit with a blue LED for air conditioning mode and a red LED for heating mode. The red heating LED also provides diagnostic blinking codes for the diesel-fired air heater.

3.4.1.1.14 Air conditioning selection and air conditioning temperature control is only functional when the blower control (S3) is in the on position.

3.4.2 The relay assembly (located in left side tool box) contains the K2 and K8 relays. The K2 relay is used for controlling turn on of the compressor. The K8 relay is used for determining if inverter AC voltage is present and will reset the bypass valve if 120 VAC power is lost. (Reference control schematic in Section 11.1.1)

3.4.3 Charge State Diagram

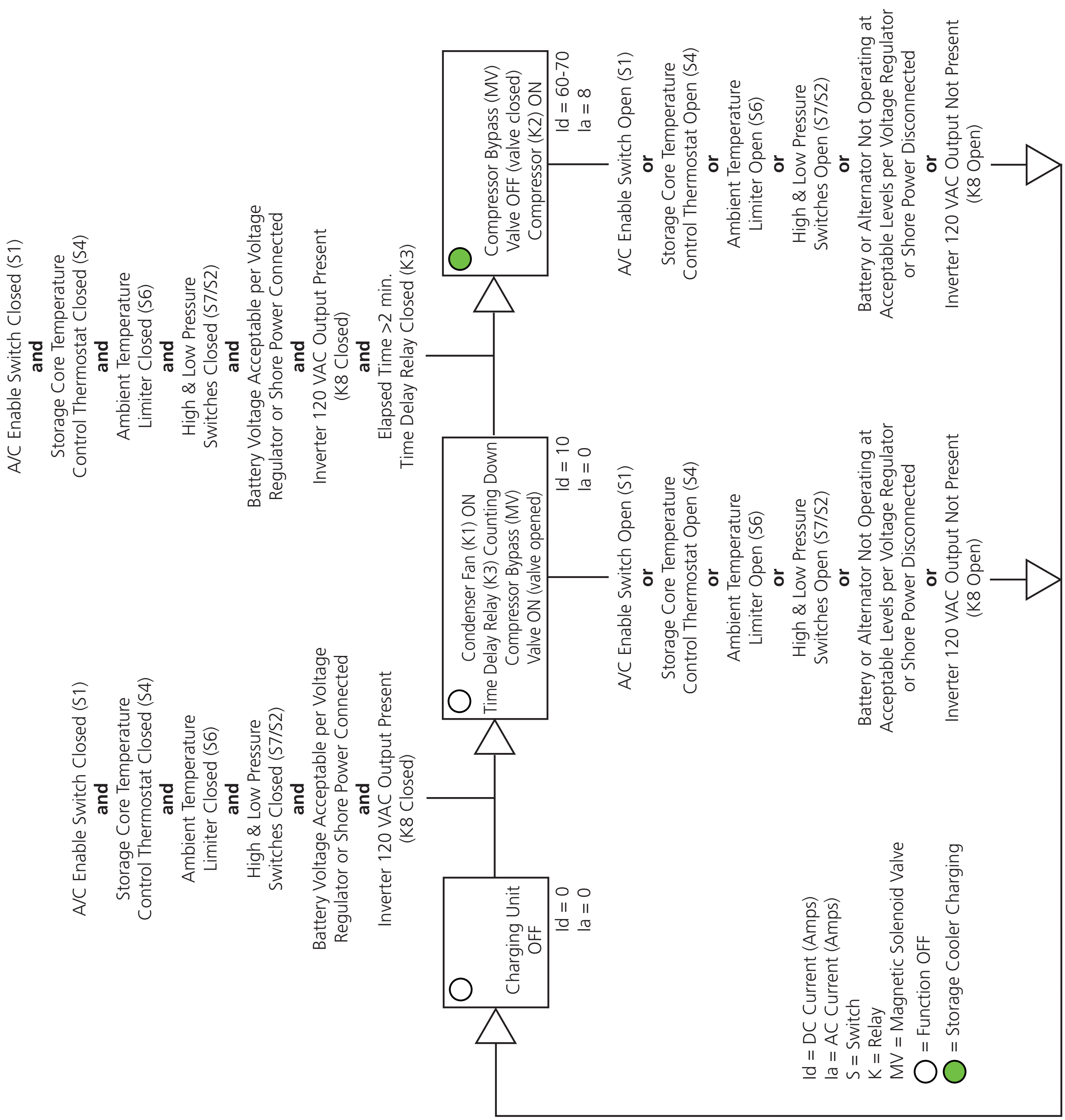


Figure 15. Charge State Diagram

3.4.4 Fresh Air, Recirculated Air State Diagram

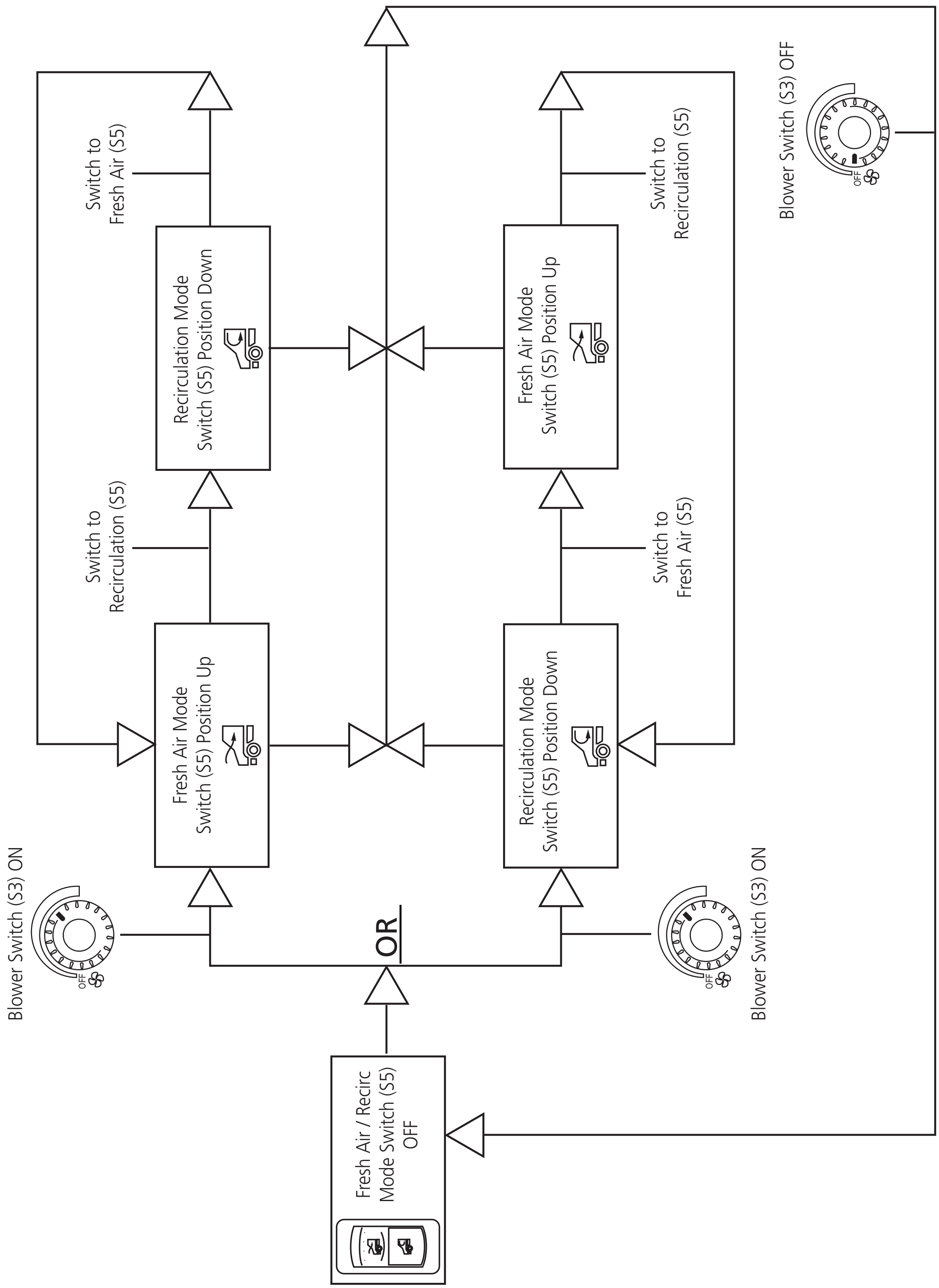


Figure 16. Fresh Air / Recirc. State Diagram

3.4.5 Cooling Discharge State Diagram

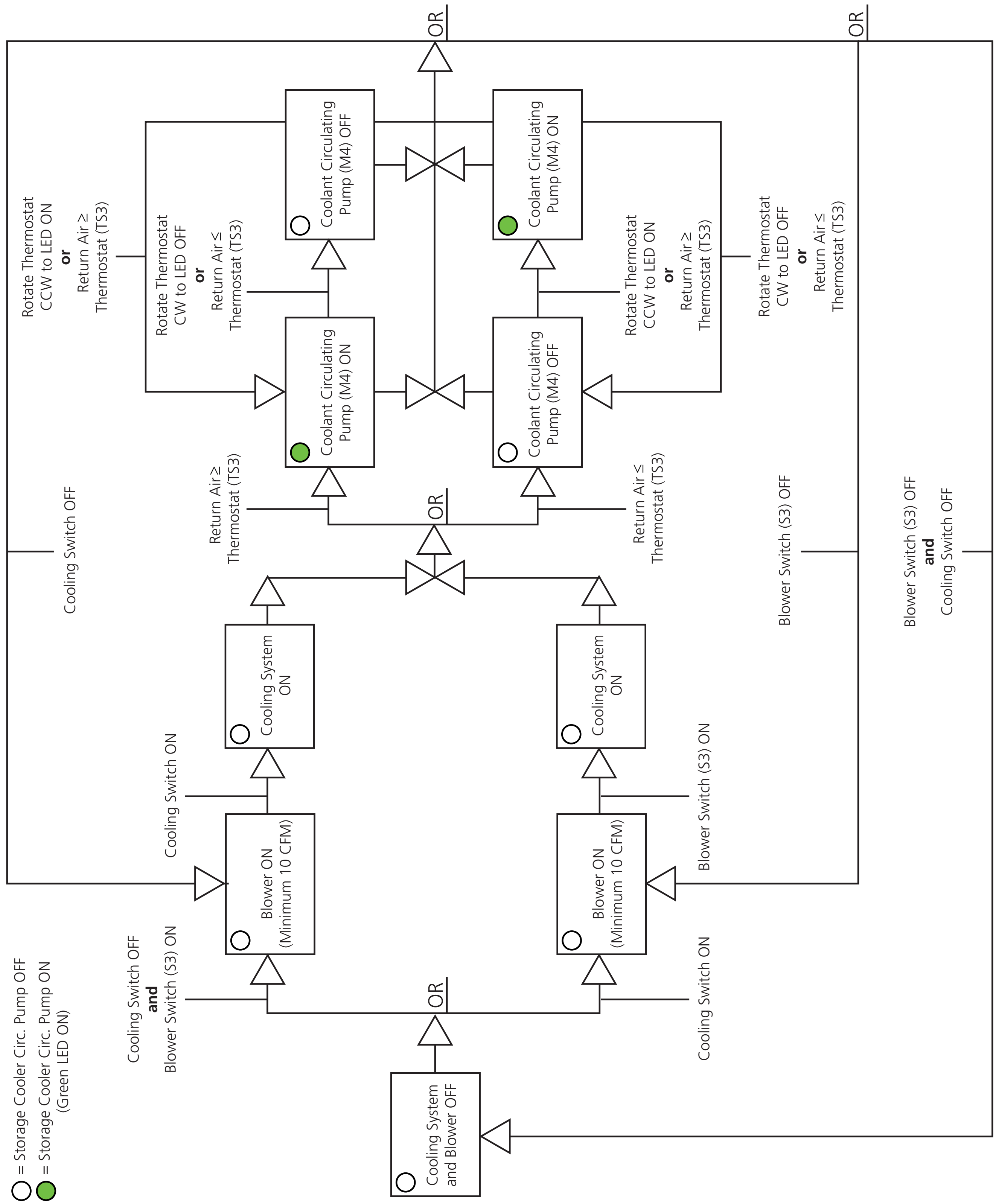


Figure 17. Cooling Discharge State Diagram

4. Troubleshooting

4.1 General Information

This section describes how to identify and remedy faults of the Kenworth Clean Power™ system.

CAUTION: Troubleshooting work demands precise knowledge of the structure and theory of operation of the various components and must be carried out by trained personnel only.

CAUTION: The troubleshooting guide is restricted to the localization of defective components. The following potential sources of malfunctions have not been included and should always be checked so that they can then be excluded as the cause of the particular fault:

- Tripped fuses or breakers
- Corrosion on terminals
- Loose terminal contact
- Poor crimp contacts on terminals
- Corroded cables and fuses
- Open circuits or short circuits in cables and wiring
- Corroded battery terminals
- Malfunctioning controls (Refer to Kenworth Clean Power™ System Service Manual)
- Malfunction with main battery box (Refer to Kenworth Clean Power™ System main battery box unit technical documentation)

The following are to be considered and eliminated as cause for malfunction:

1) Ensure that the "Charge Enable/Disable" switch located on the dashboard is functional and in the enabled up position. Note that the LED light will not illuminate unless the compressor is running.
2) Ensure that battery voltage is at an acceptable level as determined by voltage regulator when engine is running OR shore power connected.
3) 120 VAC voltage present. Ensure that the in-truck Clean Power 20A breaker is not tripped or the GFCI.
4) Ensure that the control panel is operative and functioning properly.

NOTE: As a minimum, all supporting components e.g., main battery box, control panel, that the bunk cooling system relies upon must be operational and within required parameters before proper troubleshooting of the system can be performed.

4.2 Storage Cooler Control Unit – SCCU

The following procedure will confirm the Storage Cooler Control Unit's (SCCU) functionality and eliminate it as cause for system malfunctions.

Refer to the SCCU diagram in Sec. 4.2.2 "SCCU Troubleshooting – Electrical Layout Diagram"

4.2.1 Preparation for Functional Checks

1. Disconnect connectors SCCU 1 (12-pin) and SCCU 2 (16-pin).
2. Remove cover from SCCU.
3. Apply 12 volt power to pins G/12 and H/12 of connector SCCU 1.
4. Apply ground to pins J/12 and K/12 of connector SCCU 1.
5. Follow Table 1, "Functional checks – SCCU," on page 20.

NOTE: Power and ground must be maintained throughout the SCCU testing process.

Function Check	Possible Cause for Malfunction	Remedy
Check for power out (12V) on pin F/12.	Check for open fuse F2. Check for open or short circuit within SCCU wiring.	Replace fuse F2. Repair SCCU wiring.
Check for power out (12V) on pin M/16.	Check for open fuse F6. Check for open or short circuit within SCCU wiring.	Replace fuse F6. Repair SCCU wiring.
Check for power out (12V) on pin B/12 (Condenser fan) with power (12V) applied to pins E/12 and M/12.	Check for open fuse F3. Check relay K10 and socket for power (12V) on pins 1, 3 and 5. Ground on pin 2. Check relay K1 and socket for power (12V) on pins 86, 30 and 87. Ground on pin 85.	Replace fuse F3. Repair open or short circuits. Replace defective relay K10. Repair open or short circuits. Replace defective relay K1.
(1) Check for power out (12V) on pin D/12 (Magnetic Valve) for first 2 minutes with power (12V) applied to pins E/12 and M/12.	Check for open fuse F2. Check relay K3 and socket for power (12V) on pins 30, 15 and 87a. Ground on pin 31. *Note: Pin 87a will have power for 2 minutes only afterwhich, it will switch to pin 87.*	Replace fuse F2. Repair open or short circuits. Replace defective relay K3.
(1) Check for power out (12V) on pin A/12 (Compressor) after 2 minutes with power (12V) applied to pins E/12 and M/12.	Check for open fuse F2. Check relay K3 and socket for power (12V) on pins 30, 15 and 87. Ground on pin 31.	Replace fuse F2. Repair open or short circuits. Replace defective relay K3.
Check for power out (12V) on pin A/3 (Blower Motor connector X3) with power (12V) applied to pins H/16 and variable voltage (0... 10V) to pin L/16 (Blower control signal).	Check for open fuse F6. Check relay K6 and socket for power (12V) on pins 1, 3 and 5. Ground on pin 2.	Replace fuse F6. Repair open or short circuits. Replace defective relay K6.
(2) Coolant pump circuit check: Connect a 2K linear potentiometer between pins K/16 and J/16. Connect temperature sensor TS3 to X5 connector pins A/2 and B/2. Connect power (12V) to pin G/16. Check for power out (12V) on pin N/16 and power out (12V) on connector X3, pin A/2.	Check for open fuse F5. Check thermostat module TC1 and socket for power (12V) on pins 1, 2 and OUT. Ground on pin 31.	Replace fuse F5. Repair open or short circuits. Replace defective thermostat module TC1.

Table 1. Functional checks – SCCU

Function Check	Possible Cause for Malfunction	Remedy
Fresh Air/Recirc. actuator circuit check: Connect power (12V) to pin A/16 and ground to pin B/16. Check for power out (12V) on connector X4, pin 5 (Actuator rotation CW).	Check for open or short circuit within SCCU wiring.	Repair open or short circuits.
Connect power (12V) to pin B/16 and ground to pin A/16. Check for power out (12V) on connector X4, pin 6 (Actuator rotation CCW).	Check for open or short circuit within SCCU wiring.	Repair open or short circuits.

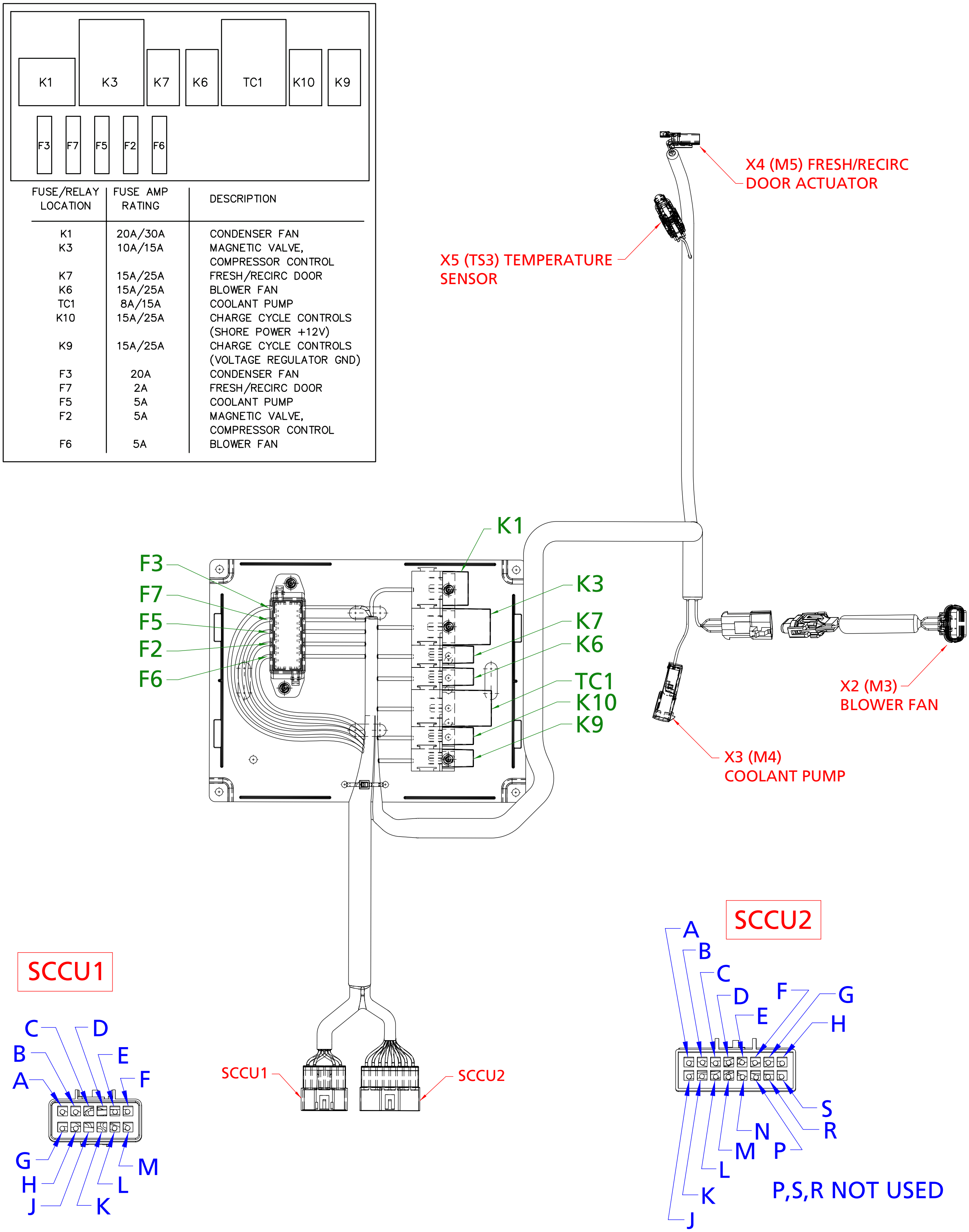
Table 1. Functional checks – SCCU

NOTES:

(1) *When E/12 and M/12 are powered the Condenser Fan (M2) is ON and the Magnetic Valve (MV) is open for the first two minutes. When two minutes have elapsed the Condenser Fan is ON and Relay K2 is closed (Compressor ON) at this time MV remains closed (no power on D/12) until power removed from pins E/12 and M/12.*

(2) *When potentiometer is set to 0 ohms, no power out on connector SCCU 2, pin N/16 and no power out on connector X3, pin A/2.*

4.2.2 SCCU Troubleshooting – Electrical Layout Diagram



FUSE/RELAY LOCATION	FUSE AMP RATING	DESCRIPTION
K1	20A/30A	CONDENSER FAN
K3	10A/15A	MAGNETIC VALVE, COMPRESSOR CONTROL
K7	15A/25A	FRESH/RECIRC DOOR
K6	15A/25A	BLOWER FAN
TC1	8A/15A	COOLANT PUMP
K10	15A/25A	CHARGE CYCLE CONTROLS (SHORE POWER +12V)
K9	15A/25A	CHARGE CYCLE CONTROLS (VOLTAGE REGULATOR GND)
F3	20A	CONDENSER FAN
F7	2A	FRESH/RECIRC DOOR
F5	5A	COOLANT PUMP
F2	5A	MAGNETIC VALVE, COMPRESSOR CONTROL
F6	5A	BLOWER FAN

4.3 Charge Unit Troubleshooting

NOTE: The control system has a built-in delayed operation feature. The charging unit compressor is delayed 2 minutes before starting operation. During this 2 minute period, the condenser fan motor (M2) is activated and the by-pass valve (MV) is opened to allow equalization of the refrigerant pressures between the suction circuit and discharge circuit.

4.3.1 Charge Unit Troubleshooting

Concern	Possible Cause	Remedy
Charge unit does not begin operation.	Core temperature control thermostat (S4) OPEN Opens at -3.3°C (26.1°F). Closes at 13.6°C (56.5°F).	*(1)* Confirm charge state of storage cooler assembly. If fully charged, it is normal for the thermostat (S4) to be open. If partly or fully discharged and thermostat remains open, replace thermostat.
Charge unit does not begin operation. *(1)* Storage cooler assembly discharged.	Open sensor / pressure switch circuits.	Disconnect 8-pin connector at the charge unit. Check for continuity across pins A/8 and C/8 of the charge unit side of connector. No continuity indicates one or more sensors (S2, S6 or S7) are open. Check sensors individually for open circuit.
	Ambient temperature limiter (S6) OPEN. Opens at 7.2°C (45°F) Closes at 12.8°C (Tolerance of ± 3.3°C) 55°F (Tolerance of ± 6°F)	Replace limiter if open at temperatures above 16°C (61°F)
	Low refrigerant pressure switch (S2) OPEN Opens at >1.03 bar (Tolerance of ± 0.24 bar) >15 psig (Tolerance of ± 3 psig) Closes at 2.13 bar (31 psig)	Confirm refrigerant pressures with A/C gauge set. If pressure above 1.27 bar (18 psig), replace sensor. If pressure below 0.8 bar (12 psig), check system for leaks and repair. Perform complete refrigerant system service.
	High refrigerant pressure switch (S7) OPEN	Pressure switch defective - replace.
Charge unit shuts down after partial system charge.	High refrigerant pressure switch (S7) OPEN. Opens at < 20.68 bar (Tolerance of ± 0.69 bar) < 300 psig (Tolerance of ±10 psig) Closes at 12.4 bar (180 psig)	Air flow over condenser blocked. Clear obstruction. Open circuit to condenser fan. Check circuits and repair. Condenser fan defective. Replace fan. Refrigerant circuit blocked. Confirm refrigerant pressures with A/C gauge set. Clear obstruction.
	Core temperature control thermostat (S4) OPENS prematurely.	Confirm open state with digital ohm meter. Replace thermostat.

Table 2. Charge unit troubleshooting

NOTES:

(1) TIP! The quickest way to determine the charge state of the storage cooler assembly is to simply switch the system on in cooling mode. After a couple on minutes on maximum output, feel the air exiting the sleeper vents. If the air is cold, allow it to continue to discharge until the charge unit compressor engages. If the air is warm and the charge unit is not responding, there is a system malfunction. For this test, ensure that the "Charge Enable/Disable" switch located on the dashboard is functional and in the enabled up position. Note that the lamp will not illuminate unless the compressor is running. It may also be necessary to connect the main battery box to a shore-power source depending on the charge state of the main batteries.

4.4 Discharging Mode Troubleshooting

4.4.1 Preparation for Troubleshooting

Set operator's control panel for cooling by:

– placing AC/Heat switch to AC (❄) mode.

– rotating temperature control dial counter clockwise to AC mode.

– rotating fan control dial clockwise to turn fan on.

4.4.2 Discharge Mode Troubleshooting

Concern	Possible Cause	Remedy
Blower fan does not turn on	No power to blower fan (M3). Blower fan defective.	Check blower fan electrical connector X2 for power out (12V) on pin A/3 and ground on pin C/3 Check for open fuse F6 and replace. Check for damaged, open or shorted wiring and repair. Replace blower fan
Blower fan operates with little or no air flow.	Air ducts blocked. Air filter dirty.	Ensure correct vents and return grilles in sleeper are open. Clean or replace air filter.
No cooling of air	No power to coolant circulating pump (M4). Coolant circulating pump defective Low coolant (Pump cavitation) No circulation due to ice-blocked storage core coolant tubes. Weak antifreeze solution or water added to system without prior mixing with antifreeze as recommended.	Check circulating pump electrical connector X3 for power out (12V) on pin A/2 and ground on pin B/2 Check for open fuse F5 and replace. Check for damaged, open or shorted wiring and repair. Replace coolant circulating pump Replenish coolant with premixed 50/50 solution of water and antifreeze to proper level and purge air from circuit. Thaw system, drain and fill with correct strength of premixed 50/50 antifreeze solution. Allow system to circulate for minimum of 15 min. and check antifreeze strength. If still weak, repeat drain, fill, circulate and test.
Cannot control sleeper cooling temperature. Storage cooler assembly quickly depleted.	Coolant circulating pump runs continuously regardless of temperature setting. Cabin temperature sensor defective.	Check for unplugged cabin temperature sensor (TS3) connector X5 or open circuit in wiring. Check sensor with digital ohm meter. 1.001kΩ at 24°C (75°F). Replace sensor if reading is incorrect or sensor is open.

Table 3. Discharge mode troubleshooting

NOTES:

(1) *The coolant circulating pump responds according to cabin temperature and position of the temperature control dial. The further counter-clockwise the dial is turned, the more frequent and longer the pump is activated to circulate coolant through the heat exchanger. For diagnostic purposes, it may be necessary to turn the dial full on to activate the pump depending on ambient temperatures in the sleeper.*

(2) ***Pure water** must **never** be introduced into the coolant circuit under any circumstances! Doing so may cause freezing and blockage within the storage cooler assembly resulting in no circulation and no sleeper cooling. Use a **premixed** 50/50 antifreeze and water solution only!*

5. Troubleshooting – Refrigerant Compressor

5.1 General Information

WARNING! 120 VAC Device. Lethal current may be present. Switch off the DC to AC power inverter and the 20 Amp. breaker in driver's side tool compartment load center before servicing.

The Kenworth Clean Power™ System uses a specifically designed refrigerant compressor for this assembly. The compressor electrical motor is the type, PSC with external surface mounted thermal and current overload protection.

This system also uses a run capacitor and a *PTCR (Positive Temperature Coefficient Resistor) to aid starting performance.

> *Current through the PTCR causes a small amount of resistive heating. If the current is large enough to generate more heat than the device can lose to its surroundings, the device heats up, causing its resistance to increase, and therefore causing even more heating. This creates a self-reinforcing effect that drives the resistance upwards, reducing the current and voltage available to the compressor after start-up.

The electrical system of this type of compressor motor is shown in Fig. 22, on pg. 33.

5.2 General Service and Safety Precautions Concerning Refrigerant Compressors

5.2.1 Introduction

The following information and procedures are courtesy of Tecumseh Products Company.

Certain information that does not pertain to the Kenworth Clean Power™ System may have been intentionally omitted from the original text for purposes of clarity.

In the interest of promoting safety in the refrigeration and air conditioning industry, Tecumseh Products Company has prepared the following information to assist service personnel in safely installing and servicing equipment. This section covers a number of topics related to safety. However, it is not designed to be comprehensive or to replace the training required for professional service personnel.

5.2.2 Trained Personnel Only

Refrigeration and air conditioning devices are extremely complicated by nature. Servicing, repairing, and troubleshooting these products should be done only by those with the necessary knowledge, training, and equipment.

WARNING! Never service, repair, or troubleshoot unless you are a professional air conditioning/refrigeration service person. Improper servicing can lead to serious injury or death from fire, electric shock, or explosion.

5.2.3 Terminal Venting and Electrocution

WARNING! Improperly servicing, repairing, or troubleshooting a compressor can lead to electrocution or fire due to terminal venting with ignition. Follow the precautions below to avoid serious injury or death from electrocution or terminal venting with ignition.

5.2.4 Fire Hazard from Terminal Venting with Ignition

Oil and refrigerant can spray out of the compressor if one of the terminal pins is ejected from the hermetic terminal. This "terminal venting" can occur as a result of a ground fault (also known as a short circuit to ground) in the compressor. The oil and refrigerant spray from terminal venting can be ignited by electricity and produce flames that can lead to serious burns or death. When spray from terminal venting is ignited this is called "terminal venting with ignition."

5.2.5 Terminal Venting and Electrocution Precautions

To reduce the risk of electrocution, serious burns, or death from terminal venting with ignition:

- *Disconnect ALL electrical power before removing the protective terminal cover.*

  Make sure that all power legs are open. (NOTE: The system may have more than one power supply, e.g. Auxiliary Shore Power.)

- *Never energize the system unless: 1) the protective terminal cover is securely fastened, and 2) the compressor is properly connected to ground.*

  Fig. 18 and Fig. 19 illustrates the means of fastening the protective terminal cover.

- *Never reset a breaker or replace a fuse without first checking for a ground fault (a short circuit to ground).*

An open fuse or tripped circuit breaker is a strong indication of a ground fault. To check for a ground fault, use the procedure outlined in “Identifying Compressor Electrical Problems” in Section 5.4.

- *Be alert for sounds of arcing (sizzling, sputtering or popping) inside the compressor. If you hear these sounds, IMMEDIATELY move away from the area of the compressor.*
- *Disconnect power before servicing.*

  Always disconnect power before servicing, unless it is required for a specific troubleshooting technique. In these situations, use extreme caution to avoid electric shock.

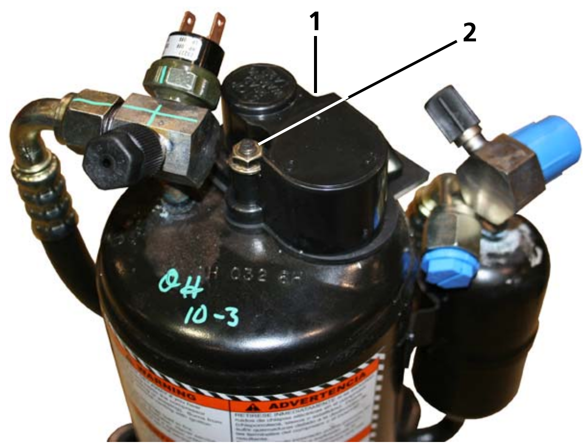


Figure 18. Compressor with protective cover (1) held in place by a hex-nut (2)

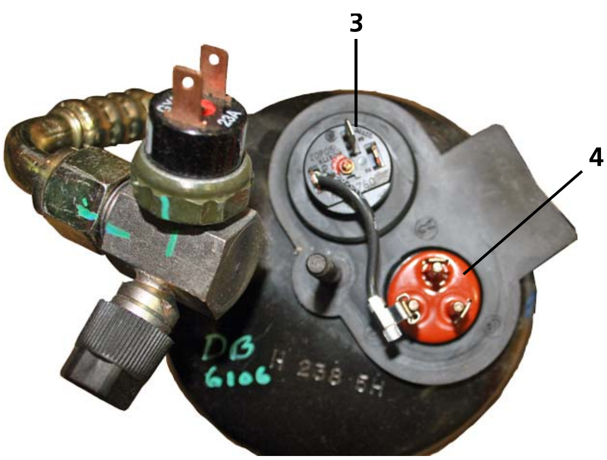


Figure 19. Thermal protection (3) and hermetically sealed terminals (4) shown with protective cover removed.

5.2.6 Refrigerants and Other Chemicals

Contact with refrigerant, mixtures of refrigerant and oil, or other chemicals can cause a variety of injuries including burns and frostbite. For example, if refrigerant contacts skin or eyes it can cause severe frostbite. Also, in the event of a compressor motor failure, some refrigerant and oil mixtures can be acidic and cause chemical burns.

To avoid injury, wear appropriate protective eye wear, gloves, and clothing when servicing an air conditioning or refrigeration system. Refer to your refrigerant supplier for more information.

If refrigerant or mixtures of refrigerant and oil come in contact with skin or eyes, flush the exposed area with water and get medical attention immediately.

5.2.7 Compressor Removal

WARNING! Failure to properly remove the compressor can result in serious injury or death from electrocution, fire or sudden release of refrigerant and oil.

Follow these precautions when removing a compressor from a system:

- *Disconnect ALL electrical power.*

  Disconnect all electrical power supplies to the system, making sure that all power legs are open. (NOTE: The system may have more than one power supply.)

- *Be sure refrigerant is recovered using the appropriate equipment before removing compressor.*

NOTE: It is recommended that the cold storage core be completely discharged (brought up to room temperature) before recovering the refrigerant. Otherwise, the system will have to be evacuated for a period not less than 2 hours to ensure any liquid refrigerant lingering in the storage core is boiled off. Place a temperature probe in one of the discharge openings of the sleeper and turn the blower on to determine the cold storage core charge state. Servicing a charged or partially charged system will give you inaccurate or false pressure readings.

- *Attempting to remove the compressor before removing all refrigerant from the system can cause a sudden release of refrigerant and oil. Among other things, this can:*
  - Cause a variety of injuries including burns and frost bite.
  - Expose service personnel to toxic gas.

To avoid serious injury or death, be sure to remove and recover all refrigerant before removing the compressor.

5.2.8 System Flushing, Purging, and Pressure Testing for Leaks

WARNING! Failure to properly flush, purge, or pressure test a system for leaks can result in serious injury or death from explosion, fire or contact with acid-saturated refrigerant or oil mists.

It is recommended that the system be serviced using a flush and purge station such as a Robinair® unit or similar equipment designed for servicing R134a refrigerant systems.

Follow these precautions when flushing/purging a system or pressure testing a system for leaks:

- *Use flushing products according to the manufacturer's instructions.*
- *To purge a system, use only dry nitrogen.*
- *When pressure testing for leaks, use only regulated dry nitrogen or dry nitrogen plus trace amounts of the serial label refrigerant, in this case, R134a.*
- *When purging or pressure testing any refrigeration or air conditioning system for leaks, never use air, oxygen or acetylene.*
    - Oxygen can explode on contact with oil.
    - Acetylene can decompose and explode when exposed to pressures greater than approximately 15 PSIG.
    - Combining an oxidizing gas, such as oxygen or air, with an HCFC or HFC refrigerant under pressure can result in a fire or explosion.
- *Use a pressure regulating valve and pressure gauges.*

  Commercial cylinders of nitrogen contain pressures in excess of 2000 PSIG at 70°F. At pressures much lower than 2000 PSIG, compressors can explode and cause serious injury or death. To avoid over pressurizing the system, always use a pressure regulating valve on the nitrogen cylinder discharge (see Fig. 20). The pressure regulator must be able to reduce the pressure down to 1 or 2 PSIG and maintain this pressure.

  The regulating valve must be equipped with two pressure gauges:

    - one gauge to measure cylinder pressure, and
    - one gauge to measure discharge or down stream pressure.

Figure 20. Dry nitrogen cylinder with attached pressure regulating and relief valves and pressure gauges needed for pressure testing for leaks and purging.

- *Use a pressure relief valve.*

  In addition to a pressure regulating valve and gauges, always install a pressure relief valve. This can also be a frangible disc type pressure relief device. This device should have a discharge port of at least 1/2" MPT size. The valve or frangible disc device must be set to release at 175 PSIG (see Fig. 20).

    - Do not pressurize the system beyond 150 PSIG field leak test pressure.

      When field testing a system for leaks, 150 PSIG is adequate test pressure.
    - Disconnect nitrogen cylinder and evacuate the system before connecting the refrigerant container.

      Disconnect the nitrogen cylinder and release the pressure in the system before connecting a refrigerant container to the system. The higher pressure gas in the system can explode the refrigerant container.

5.2.9 System Charging

WARNING! Failure to properly charge the system can result in serious injury or death from explosion or fire.

Follow these precautions when charging a system.

- *Do not operate the compressor without a charge in the system.*

  Operating the compressor without a charge in the system can damage the hermetic terminal. As always, to avoid serious injury or death from terminal venting with ignition, never energize the compressor unless the protective terminal cover is securely fastened.

- *Use proper refrigerant.*

  Use only the serial label refrigerant when charging the system. Using a different refrigerant can lead to excess system pressure and an explosion. Use of a refrigerant other than the serial label refrigerant will void the compressor warranty.

- *Do not overcharge a refrigerant system.*

  Overcharging a refrigeration system can result in an explosion. To avoid serious injury or death, never overcharge the system. Always use proper charging techniques. Limit charge amounts to those specified on the system equipment serial label or in the original equipment manufacturer's service information.

  Overcharging the system immerses the compressor motor, rotor, and related parts in liquid refrigerant. This creates a hydraulic block preventing the compressor from starting. The hydraulic block is also known as locked rotor.

  Continued supply of electricity to the system causes heat to build in the compressor. This heat will eventually vaporize the refrigerant and rapidly increase system pressure. If, for any reason, the thermal protector fails to open the electrical circuit, system pressure can rise to high enough levels to cause a compressor housing explosion.

NOTE: It is recommended that the cold storage core be completely discharged (brought up to room temperature) before servicing the refrigerant circuit. Place a temperature probe in one of the discharge openings of the sleeper and turn the blower on to determine the cold storage core charge state. Servicing a charged (frozen) or partially charged (cold) system will give you inaccurate or false pressure readings.

5.2.10 Capacitor Overheating

An overheated run/start capacitor can burst and spray or splatter hot material which can cause burns. Applying voltage to a run/start capacitor for more than a few seconds can cause the capacitor to overheat.

Check capacitors with a capacitance meter, and never check a capacitor with the power on.

5.2.11 System Evacuation

Never use a compressor to evacuate a system. Instead, use a high vacuum pump specifically designed for that purpose.

Never start the compressor while it is under deep vacuum. Always break a vacuum with refrigerant charge before energizing the compressor.

Failure to follow these instructions can damage the hermetic terminal. As always, to avoid serious injury or death from terminal venting with ignition, never energize the compressor unless the protective terminal cover is securely fastened.

5.2.12 Follow the Labels

Tecumseh Products Company compressors have labels and markings with important information. For your safety and the safety of others, read the labels and markings on the product.

5.3 Troubleshooting Table – Refrigerant Compressor and Related Components

This section provides information to assist service personnel in identifying compressor problems. It provides a general troubleshooting table that relates complaints or problems to possible causes and solutions. This section also provides greater detail about specific compressor problems.

For your safety, read and follow the "General Service and Safety Precautions Concerning Refrigeration Compressors" in Section 5.2.

This Troubleshooting Table is not designed to replace the training required for a professional air conditioning/ refrigeration service person, nor is it comprehensive.

Symptom	Possible Causes	Remedy
Compressor will not start – no audible hum	Thermal protector not working properly.	Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
	Wiring improper or loose.	Check against wiring diagram and wire properly.
	Compressor motor has a ground fault (also known as a short circuit to ground).	Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
Compressor will not start – hums but trips on thermal protector	Improperly wired.	Check against wiring diagram and wire properly.
	Low voltage to compressor.	Turn off system until proper voltage is restored.
	Compressor electrical problems: a. Compressor motor has a winding open or shorted. b. Start capacitor or PTCR not working properly. c. Relay does not close.	Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
	Internal mechanical troubles in compressor.	Refer to "Checking for Adequate Compressor Pumping" in Section 5.5.
Compressor starts, but does not switch off of start winding	Improperly wired.	Check against wiring diagram and wire properly.
	Low voltage to compressor.	Turn off system until proper voltage is restored.
	Compressor electrical problems: a. Compressor motor has a winding open or shorted. b. Relay failing to open. c. Run capacitor not working properly.	Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
	Discharge pressure too high.	
	Internal mechanical trouble in compressor.	Refer to "Checking for Adequate Compressor Pumping" in Section 5.5.

Table 4. Refrigerant compressor and related components troubleshooting

Symptom	Possible Causes	Remedy
Compressor starts and runs, but short cycles on thermal protector	Too much current passing through thermal protector: a. Extra sources of current draw. b. Compressor motor has winding shorted.	Check for extra sources of current passing through thermal protector, such as fan motors, pumps. (This would be extremely rare as this system is not designed for such use.) Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
	Low voltage to compressor.	Turn off system until proper voltage is restored.
	Compressor electrical problems, such as thermal protector or run capacitor not working properly.	Refer to "Identifying Compressor Electrical Problems" in Section 5.4.
	Discharge pressure too high.	
	Suction pressure too high.	
	Return gas too warm.	Check condenser fan for malfunction
Unit runs OK, but run cycle is shorter than normal (due to component (s) other than thermal protector)	System components, such as storage temperature control thermostat, SCCU, relays, not functioning properly.	Refer to the information contained within Section 4 "Troubleshooting".
	High pressure cut-out due to: a. Insufficient air flow over condenser. b. Overcharge of refrigerant. c. Air in system.	Refer to the information contained within Section 4 "Troubleshooting".
	Low pressure cut-out due to: a. Refrigerant leaking. b. Undercharge of refrigerant. c. Restriction in Thermal Expansion Valve.	Refer to the information contained within Section 4 "Troubleshooting".
Unit operates long or continuously	Undercharge of refrigerant.	Check for leak and correct. Perform full refrigerant service on system.
	System components, such as storage temperature control thermostat, SCCU, relays, not functioning properly.	Refer to the information contained within Section 6 and Section 7.
	Restriction in refrigeration circuit.	Refer to the information contained within Section 6 and Section 7.
	Dirty condenser.	Refer to the information contained within Section 6 and Section 7.
Suction line frosted or sweating	System problems, such as: a. Expansion valve stuck open. b. Overcharge of refrigerant.	Refer to the information contained within Section 6 and Section 7.
Liquid line frosted or sweating	System problems such as, restriction in dehydrator or strainer.	Refer to the information contained within Section 6 and Section 7.
System rattles or vibrates during operation.	Loose parts or mountings, tubing rattle, bent fan blade causing vibration, fan motor bearings worn, etc.	Repair or replace loose, worn, defective parts.

Table 4. Refrigerant compressor and related components troubleshooting

5.4 Identifying Compressor Electrical Problems

This section describes procedures for checking the compressor's electrical circuits and components. Before doing so, ensure that the Kenworth Clean Power™ System is operational and that all power sources are present. Make sure the core temperature control thermostat, SCCU, and relays are working properly.

Whenever you suspect that there is an electrical problem with the compressor (for example, there has been a tripped circuit breaker):

- FIRST, check for a ground fault (also known as a short circuit to ground) in the motor using a megohmmeter ("megger") or a Hi-Potential Ground Tester ("Hi-Pot") (Section 5.4.1).
- SECOND, check the motor windings for proper continuity and resistance (Section 5.4.2).
- THIRD, check the compressor's electrical components (Section 5.4.3).

When checking for electrical problems, it is important to follow all safety precautions (see warning below) and use the proper equipment and procedures.

⚠ ***WARNING! Oil and refrigerant can spray out of the compressor if one of the terminal pins is ejected from the hermetic terminal.***
This can occur as a result of a ground fault in the compressor. The oil and refrigerant spray can be ignited by electricity and produce flames that can lead to serious burns or death. If this spray is ignited it is called "terminal venting with ignition".

To reduce the risk of electrocution, serious burns or death from terminal venting with ignition:

- Disconnect ALL electrical power before removing the protective terminal cover.
- Never energize the system unless:
    - the protective terminal cover is securely fastened, and
    - the compressor is properly connected to ground.
- Never reset a breaker or replace a fuse without first checking for a ground fault. An open fuse or tripped circuit breaker is a strong indication of a ground fault.
- Be alert for sounds of arcing (sputtering or popping) inside the compressor. If you hear these sounds, IMMEDIATELY move away from the area of the compressor.

5.4.1 Checking for a Ground Fault (a Short to Ground)

Step 1: Disconnect Power
Disconnect all electrical power supplies to the system, making sure that all power legs are open.
(NOTE: The system may have more than one power supply.)

Step 2: Check for a Ground Fault
Remove the protective terminal cover. If there is any evidence of overheating at any lead, this is a good indication that a compressor motor problem exists. At this time, do not replace or attach leads or connectors that have been damaged by overheating.
Disconnect leads and/or remove all components (such as relays and capacitors) from the terminal pins.

⚠ ***WARNING! If a capacitor is present, using a 20,000 ohm resistor, discharge it before removing it from the system to avoid damage to measuring devices and risk of electric shock.***
When removing a current type relay, keep it upright.

Check the compressor for a ground fault using either a megohmmeter ("megger") or a Hi-Potential Ground Tester ("Hi-Pot") (See examples in Fig. 21).

⚠ ***WARNING! To reduce the risk of electrocution, always follow the manufacturers' procedures and safety rules when using these devices.***

Connect one lead of either the megger or Hi-Pot to the metal suction line or similar compressor ground point. Connect the other lead to one of the terminal pins.

Repeat this procedure for the two remaining terminal pins. If the instrument indicates any resistance less that 2 megohms between any pin and the housing (metal suction line), a ground fault exists.

⚠ ***WARNING! To avoid electric shock, electrocution, and terminal venting with ignition do not energize a compressor that has a ground fault.***

If a ground fault exists, keep the power off and replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" starting on Section 6.1.

If the compressor is not replaced immediately, mark and red tag the compressor to indicate there is a ground fault. Do not reconnect the power leads. Tape and insulate each power lead separately.

If a ground fault does not exist, leave the power off and all external components disconnected from the terminal pins.

Check for continuity and proper resistance using the procedure under Section 5.4.2.

Why use a megger or Hi-Pot?

A conventional ohmmeter will not reliably detect a ground fault under certain circumstances.

A megohmmeter ("megger") is a special type of ohmmeter that is capable of measuring very high resistances by using high voltages.
A Hi-Potential Ground Tester ("Hi-Pot") is a device that uses high voltages to measure the flow of current across the insulation. Unlike an ohmmeter, even one that can measure millions of ohms, a megger or a Hi-Pot can detect a breakdown in motor winding insulation before the motor fails.

WARNING! To reduce the risk of electrocution, always follow the manufacturers' procedures and safety rules.

"megger"

"Hi-Pot"

Figure 21. "Megger" and "Hi-Pot"

5.4.2 Checking for Continuity and Proper Resistance

If no ground fault has been detected using the procedures under Section 5.4.2, determine whether there is an open or short circuit in the motor windings or if the heater element of the thermal protector is open.

Use the procedures in Table 5 to check the single phase motor.

Step 1: Allow Thermal Protector to Reset	When servicing single compressors with internal thermal protectors, be sure to allow time for the thermal protector to reset prior to starting these electrical wiring checks.
Step 2: Check Continuity	Check the start winding by measuring continuity between terminal pins C and S. (See "Identification of Hermetic Terminal" on page). If there is no continuity, replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" under Section 6.1. Check the run winding by measuring continuity between terminal pins C and R. If there is no continuity, replace the compressor.

Table 5. Checking for Proper Continuity and Resistance

Step 3: Measure the Resistance	Measure the resistance (ohms) between each pair of terminal pins: C and S, C and R, and S and R. Add the resistance between C and S to the resistance between C and R. This sum should equal the resistance found between S and R. A small deviation in this comparison is acceptable. For this compressor, the resistance values at a nominal temperature of 21° C (70° F) should be within: C & S = 4.0 to 5.2 ohms C & R = 0.7 to 0.85 ohms S & R = 4.7 to 6.05 ohms If the resistance is not correct, replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" under Section 6.1. If the resistance is correct, leave the leads off and follow the instructions in the next section to check other compressor electrical components.

Table 5. Checking for Proper Continuity and Resistance

5.4.3 Checking for Other Electrical Problems in Single Phase Motors

This section provides procedures for checking the components such as the thermal protector, relay and capacitor in a single phase compressor. Refer to Table 6, "Troubleshooting PSC Compressor Circuits," on page 34.

The Kenworth Clean Power™ System uses a specifically designed refrigerant compressor for this assembly. The compressor electrical motor is the type, PSC with external surface mounted thermal and current overload protection. This system also uses a run capacitor and a PTC Resistor starting aid.

The electrical system of this type of compressor motor is shown in Fig. 22.

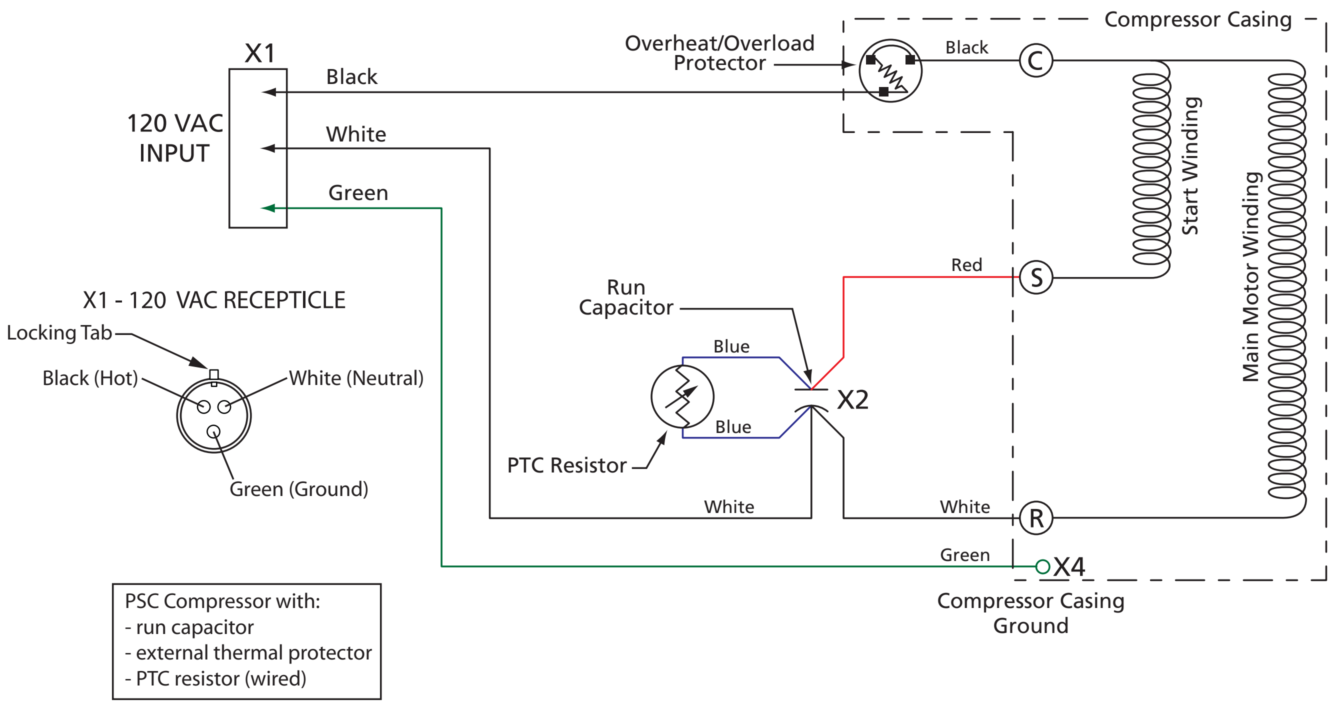


Figure 22. PSC Compressor Motor with External Thermal/Current Protector, Run Capacitor and PTCR

Step 1: Before Continuing with Troubleshooting...	***WARNING! All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (refer to "Checking for a Ground Fault" under Section 5.4.1).*** You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" under Section 5.4.2) making sure the system is getting proper voltage and that all controls, thermostats, etc. are working properly.
Step 2: Check Wiring	Confirm that there is continuity between C and the thermal protector common lead wire.
Step 3: Check External Thermal Protector	Check for continuity across the thermal protector. If there is no continuity, then the thermal protector may be tripped. Wait at least 5 minutes, then check continuity again. If there is still no continuity, replace the thermal protector.
Step 4: Check Run Capacitor	***WARNING! Using a 20,000 ohm resistor; discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.*** Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be ±10% of the marked capacitor value. As an alternative, check the run capacitor by measuring continuity across the capacitor terminals: a. Rx1 scale: If there is continuity, then the capacitor is shorted out and needs to be replaced. b. Rx100,000 scale: If a digital multi-meter (DMM) indicates infinite resistance, then the run capacitor is open and needs to be replaced. Possible reasons that a run capacitor is not working properly include: • Use of incorrect run capacitor. Replace with proper run capacitor. • Line voltage is too high (greater than 110% of rated voltage). • Rust-through of capacitor housing or severe corrosion of terminals. Replace with new capacitor (Webasto now offers a weather protected replacement).
Step 5: Reconnect Run Capacitor	Reconnect the run capacitor into the circuit as before. (See wiring schematic under Section 11.1.1.) Observe color code markings on schematic.
Step 6: Continue Troubleshooting	If all the above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure under Section 5.5.

Table 6. Troubleshooting PSC Compressor Circuits

5.5 Checking for Adequate Compressor Pumping

Before checking for adequate compressor pumping, you should have already checked for compressor electrical problems as outlined in "Identifying Compressor Electrical Problems" under Section 5.4.

To check for adequate pumping, connect service gauges to system. Then turn on power to system. If the system has an adequate refrigerant charge, the compressor should maintain at least 200 psig pressure differential between the suction and discharge. If the compressor does not pump adequately, it must be replaced with no further testing.

5.6 Is Your Compressor Eligible for Return Under Warranty?

Authorized Tecumseh wholesalers are asked to test every in-warranty compressor that is returned to them. The Tecumseh factory tears down and examines a representative sample of compressors returned by authorized wholesalers and notes the reason for failure. In the field, it can be determined if a compressor is eligible for return under warranty by FIRST checking for adequate compressor pumping. If the compressor passes all electrical troubleshooting tests and pumps adequately, the compressor is operating properly and the problem lies elsewhere in the system.

A. Check the Compressor for Electrical Problems

Using the procedures in "Identifying Compressor Electrical Problems" under Section 5.4, check the compressor for electrical problems.

B. Check for Adequate Compressor Pumping

Connect services gauges to the system. Turn on power to system. If the system has an adequate refrigerant charge, the compressor should maintain at least 200 psig pressure differential between the suction and discharge. If the compressor does not pump adequately, it must be replaced with no further testing.

6. Compressor Replacement and System Service

6.1 System Cleanup and Compressor Replacement After Compressor Failure

Once you determine that a compressor needs to be replaced you must then determine whether the system has been contaminated. Compressor motor failure can lead to such contamination. (While compressor motor failure is sometimes referred to as motor "burnout", it does not mean that a fire actually occurs inside a hermetic compressor.) Even small amounts of contamination must be removed from the system to avoid damaging the replacement compressor. Therefore, it is important to thoroughly clean a refrigeration/air conditioning system if system contamination is present.

CAUTION: If a compressor motor failure has occurred, refrigerant or mixtures of refrigerant and oil in the system can be acidic and cause chemical burns.

As always, to avoid injury, wear appropriate protective eye wear, gloves and clothing when servicing an air conditioning or refrigeration system. If refrigerant or mixtures of refrigerant and oil come in contact with skin or eyes, flush the exposed area with water and get medical attention immediately.

The following outlines a process for compressor replacement and system clean-up for a system equipped with a Tecumseh compressor. You should refer to the original equipment manufacturers (OEM) service information.

A. Determine Extent of System Contamination

Following the precautions in "Refrigerants and Other Chemicals" under Section 5.2.6 and Compressor Removal" under Section 5.2.7, remove the compressor.

Use the following guidelines to determine whether contamination, if any, is limited to the compressor or extends to the system.

If the discharge line shows no evidence of contamination and the suctions tube is clean or has only light carbon deposits, then the contaminants are limited to the compressor housing (Compressor Housing Contamination). A single installation of liquid and suction line filter-driers should clean up the system.

If, however, the discharge line or the suction line shows evidence of contamination, the compressor was running at the time of the motor failure and contaminants were pumped throughout the system (System Contamination). If System Contamination has occurred, several changes of the liquid and suction line filter-driers will be needed to cleanup the system. In addition, the thermal expansion valve will need to be replaced.

B. Install Replacement Compressor and Components

1. Install the replacement compressor with new external electrical components (capacitors, relay, overload, etc., where applicable).
2. Install an oversized liquid line filter-drier.
3. Install a generously sized suction line filter-drier immediately upstream of the compressor. The drier when permanently installed in a clean system must have a pressure drop not more than 2 psi, or initially installed in a dirty system temporarily, must have a pressure drop not more than 9 psi. Pressure taps must be supplied immediately before and after the suction filter-drier to permit the pressure drop to be measured.

   If a suction line accumulator is present and System Contamination has occurred, it must be thoroughly flushed to remove any trapped sludge and thus prevent if from plugging the oil return hole. The filter-drier should be installed upstream of the accumulator and the compressor.

   In case of Compressor Housing Contamination, the filter-drier should be installed between the compressor and the suction line accumulator.

   Rubber refrigeration hoses are not satisfactory for temporarily hooking up the suction line filter-drier to the system since the acid quickly breaks down the rubber and plastic.
4. Follow the Precautions in "System Flushing, Purging, and Pressure Testing for Leaks" under Section 5.2.8, to purge the system and pressure test for leaks.

E. Evacuate the System

Evacuate the system to less than 1000 microns, using a good vacuum pump (not a compressor) and an accurate high vacuum gauge. Operate the pump at 1000 microns, or less, for several hours to be sure the vacuum is maintained.

Alternate method of removing moisture and non-condensable material from the systems is:

1. Evacuate the system to 29 inches vacuum. Break vacuum with refrigerant to be used for final charging of system and vapor charge to 35-50 pounds gauge pressure. Leave vapor charge in system for a minimum of five minutes. Reduce pressure to 0 gauge pressure.
2. Repeat step 1.
3. Evacuate system to 29 inches vacuum. Charge system with the specified kind and quantity of refrigerant.

CAUTION: Never use a compressor to evacuate a system. Instead, use a high vacuum pump specifically designed for that purpose.

CAUTION: Never start the compressor while it is under deep vacuum. Always break a vacuum with refrigerant charge before energizing the compressor.

WARNING! Failure to follow these instructions can damage the hermetic terminal and may result in terminal venting. As always, to reduce the risk of serious injury or death from fire due to terminal venting, never energize the compressor unless the protective terminal cover is securely fastened.

D. Charge the System and Check the Pressure Drop

Charge the system and place in operation. Follow the safety precautions outlined under "System Charging", Section 5.2.9. Immediately after startup, check the pressure drop across the suction line filter-drier. This will serve two purposes:

- Verify that the drier selection was correct; that is, large enough.
- Serve as a base point to which subsequent pressure checks can be compared.

Because the permissible pressure drop across the drier is relatively small, it is suggested that a differential pressure gauge be used for the measurement.

E. Measure the Pressure Drop

After the system has been operating for an hour or so, measure the pressure drop across the suction line filter-drier.

In the case of Compressor Housing Contamination, little change should be noted. The pressure drop will, in most instances, be below that tolerable (2 psi) for a permanent installation as described under Section 6.1, paragraph B, item 3.

On the other hand, where Systems Contamination occurred, an increased pressure drop will be measured. Change the suction filter-drier *and* the liquid line filter-drier whenever the pressure drop approached or exceeds 9 psi allowed for temporary operation during cleanup.

Keep changing both the suction and liquid line filter-driers until the pressure drop stabilizes at or below 2 psi for permanent operations in a system. At this point, it is the service person's option as to whether to leave the suction drier in the system or remove it from operation.

If the system is to be opened to permit the permanent removal of the suction filter-drier then the liquid line filter-drier should be changed once more.

F. Test for Acidity if Multiple Motor Failures Have Occurred

If the system has suffered multiple motor failures, it is advisable that the oil of the replacement be tested after Section E and judged acid free before the system is considered satisfactorily cleaned.

An oil sample may be taken from a hermetic system if at the time the replacement compressor was installed an oil trap is installed in the suction line (see Fig. 23).

When the trapped oil level appears in the sight glass (less than an ounce is needed) the oil may be *slowly* transferred to the beaker of the acid test kit as available from several manufacturers. A reading of less that 0.05 acid number is an indication that the system is free of acid. A reading of higher than 0.05 means continued cleaning is required. Return to Section 6.1, paragraph B, item 2.

G. Monitor the System

The above procedure for the cleanup of hermetic systems after motor failure through the use of suction line filter-drier will prove satisfactory in most instances *provided* the system is monitored and kept clean by repeated drier changes, if such are needed. The failure to follow these *minimum cleanup recommendations* will result in an excessive risk of repeat motor failure.

Oil Sampler

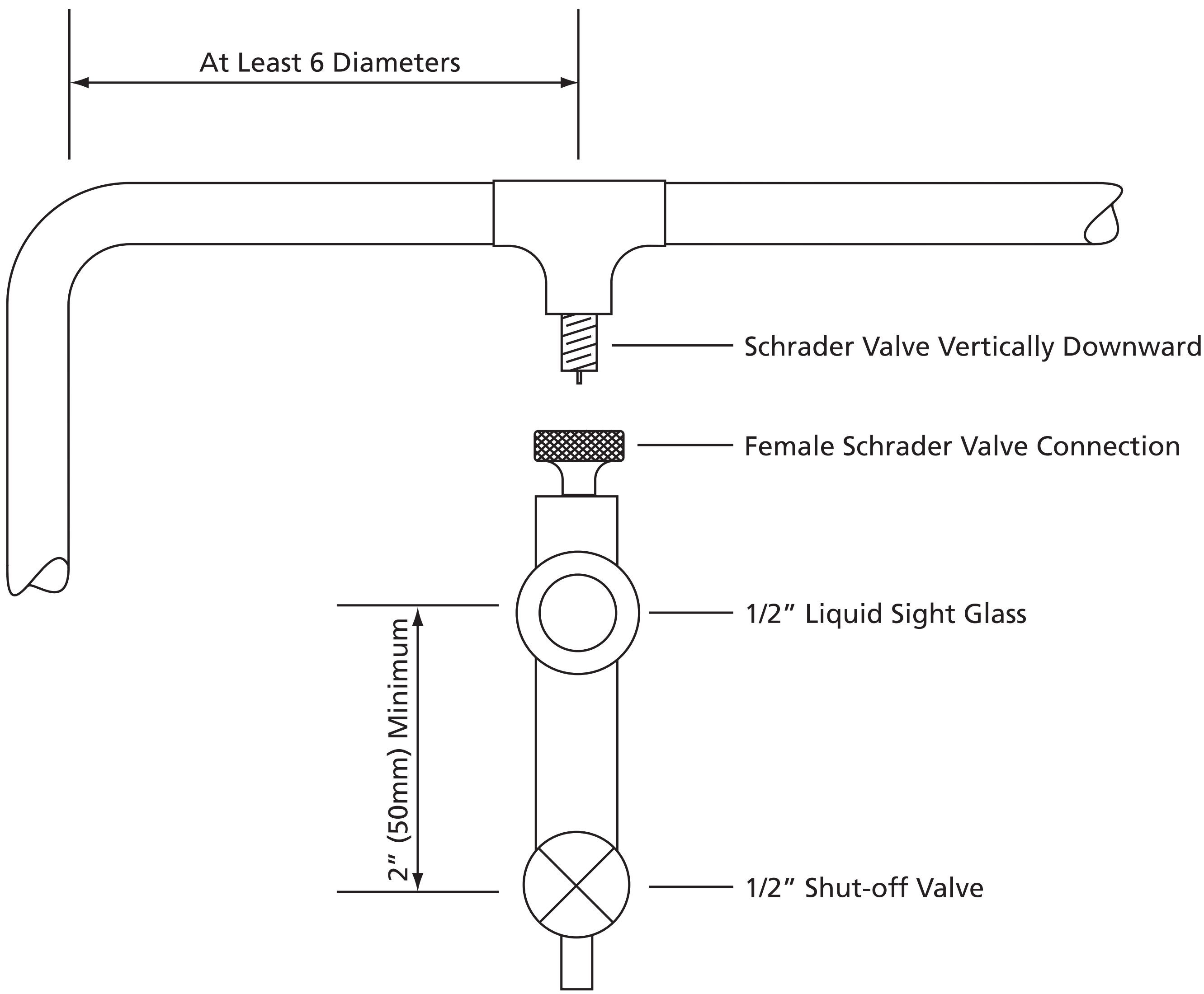


Figure 23. Mehtod of obtaining oils sample on a hermetic system. After satisfactory oil test, Schrader valve may be capped and oil sampler retained for next job.

7. Component Replacement - Refrigeration Unit

7.1 General Information and Safety Precautions

Refrigeration and air conditioning devices are extremely complicated by nature. Servicing, repairing, and troubleshooting these products should be done only by those with the necessary knowledge, training, and equipment.

Before replacement of components, a thorough troubleshooting and diagnosis of the Kenworth Clean Power™ System must be conducted to identify the reason for the component failure and the correct remedy.

WARNING! Never service, repair, or troubleshoot unless you are a professional air conditioning/refrigeration service person. Improper servicing can lead to serious injury or death from fire, electric shock, or explosion.

WARNING! Failure to properly remove the compressor and related components can result in serious injury or death from electrocution, fire or sudden release of refrigerant and oil.

Follow these precautions when removing components from the refrigeration circuit:

- *Disconnect electrical power.*

  Disable the 120 VAC power source by switching off the DC to AC power inverter and the 20 Amp. breaker in the driver's side tool compartment load center. Ensure it remains off while working on and around the compressor. Observe Fig. 49 "120 VAC system" for reference.

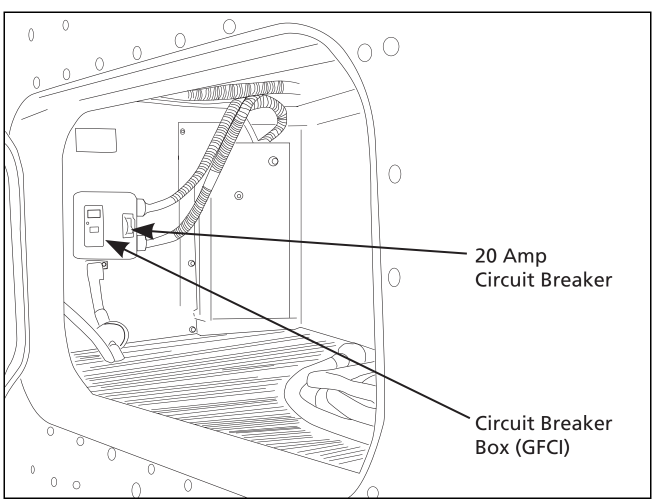


Figure 24. Breaker box inside driver side tool box

- *Be sure refrigerant is recovered using the appropriate equipment before removing any of the refrigeration circuit components.*

  Attempting to remove components before removing all refrigerant from the system can cause a sudden release of refrigerant and oil.
  Among other things, this can:

  - Cause a variety of injuries including burns and frost bite.
  - Expose service personnel to toxic gas.

WARNING! To avoid serious injury or death, be sure to remove and recover all refrigerant before removing components of the refrigeration circuit.

7.2 Charging Unit Removal

Depending on the degree of service work required, it may be advantageous to remove the charge unit for repairs off the vehicle.

Removal steps:

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove left side fairings of vehicle if applicable.
3. Remove charging unit housing top panel.

Figure 25. Top panel removed

4. Connect a refrigerant recovery station to the charging ports and recover the refrigerant.

Be sure refrigerant is recovered using the appropriate equipment. Webasto recommends that the system be serviced using a recovery, recycling and recharging station such as a Robinair® unit or similar equipment designed for R134a refrigerant systems.

Figure 26. Refrigerant Recovery

5. Disconnect recovery station.
6. Disconnect the 5700 Series One-Shot™ suction line (①) and liquid line (②) bulkhead connections of charging unit. Seal open lines and fittings to prevent the ingress of contaminates.

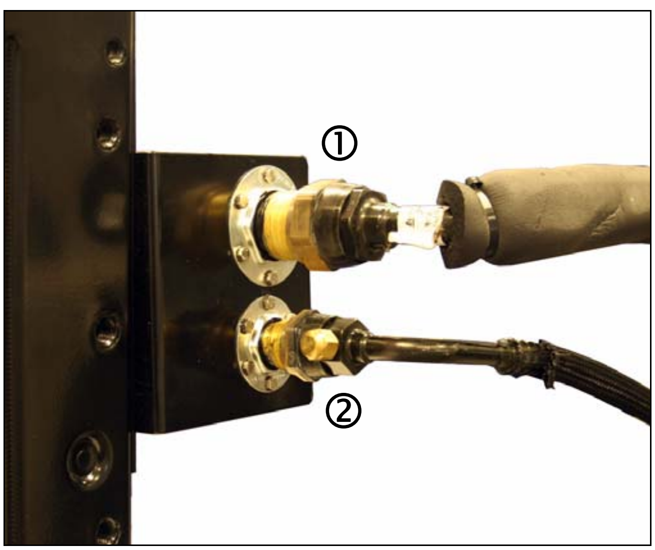


Figure 27. Refrigerant line connections (Quick-Connect)

NOTE: See "Appendices" on page 59 for information regarding reconnecting of the 5700 Series One-Shot™ Brass Couplings.

7. Disconnect 120 VAC power cable (③) and 12 VDC harness (④) connectors.

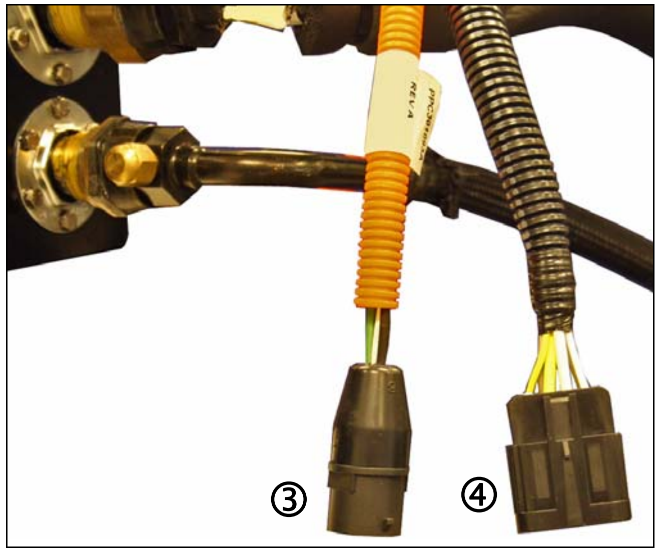


Figure 28. 120 VAC and 12 VDC power harnesses

Non-Fairing (Frame mount) application:

8. Loosen the two bolts, top and second from the top on both sides of the charging unit to frame bracket.
9. Remove the bottom bolt on both sides of the charging unit and frame bracket.

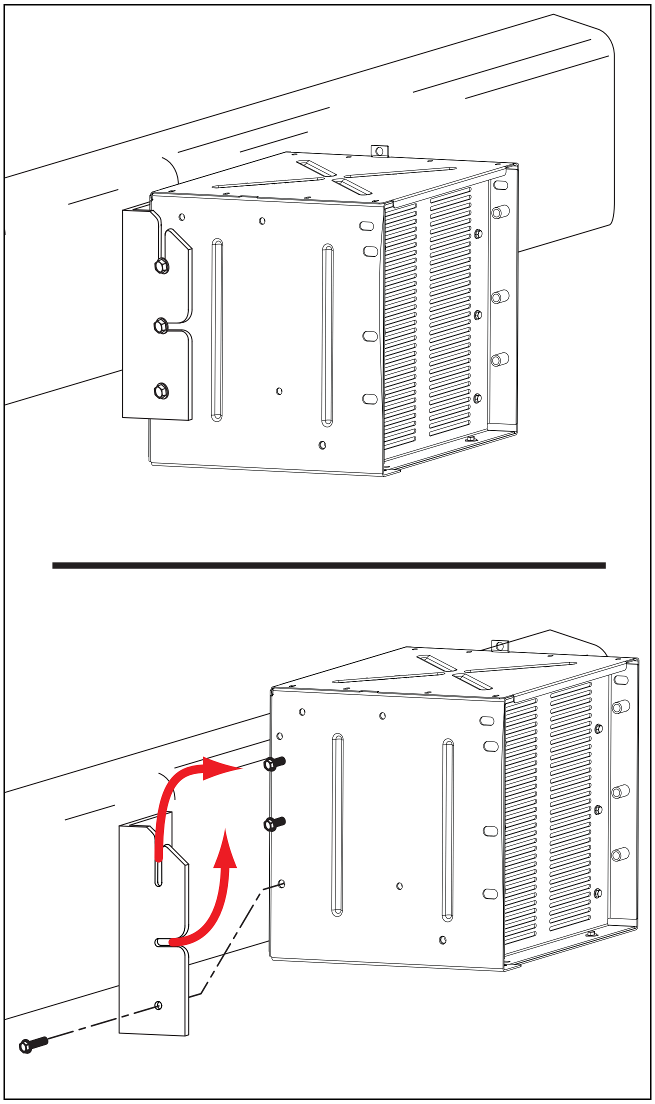


Figure 29. Non-Fairing (Frame mount) application

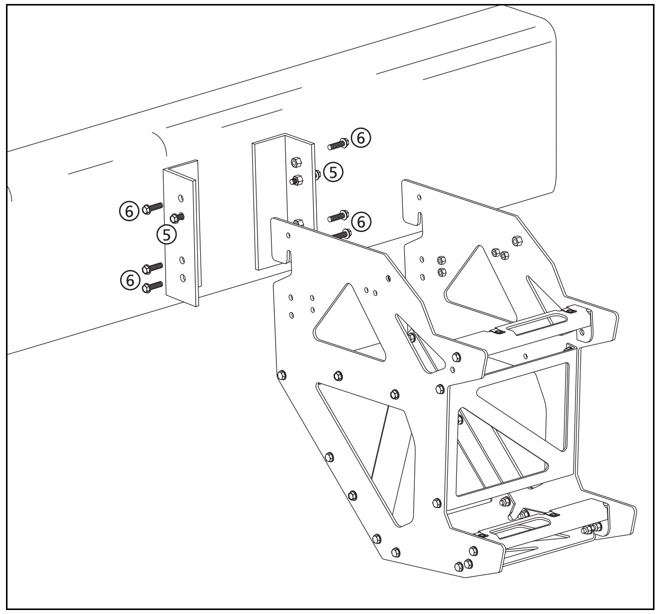


Figure 30. Fairing mount structure to frame attachment

14. Remove the fairing structure by removing the four bolts ⑦ and one bolt with lock-nut ⑧ on each side.

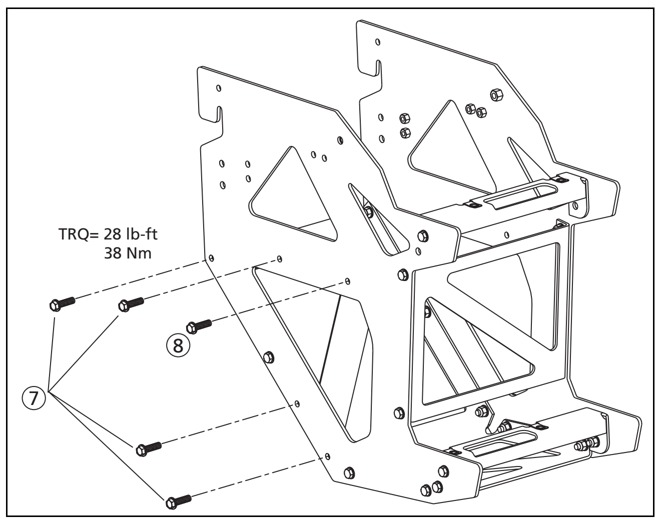


Figure 31. Fairing mount structure removal

Application with Fairing Mount Structure:

10. Loosen the top bolt (⑤), on both sides of the fairing mount structure to frame bracket.
11. Remove the remaining two or three bolts (⑥) on both sides.
12. With assistance of a lifting device, lift the charging unit up and off the two loosened bolt.
13. Place unit on workbench.

7.2.1 Installation

1. Reassemble and install in reverse order.
2. Service system according to the recommendations under Section 5.2.8 and Section 5.2.9.

NOTE: See "Appendices" on page 59 for information regarding reconnecting of the 5700 Series One-Shot™ Brass Couplings.

7.3 Side Panel Removal for Access

1. Remove two hex-nuts holding the refrigerant filter to side panel.
2. Remove hex-nut holding the run capacitor to side panel.
3. Remove seven hex-bolts, four along the back panel (①), two under the side panel (②) and one at the lower corner of the condenser shroud (③). See Fig. 32.

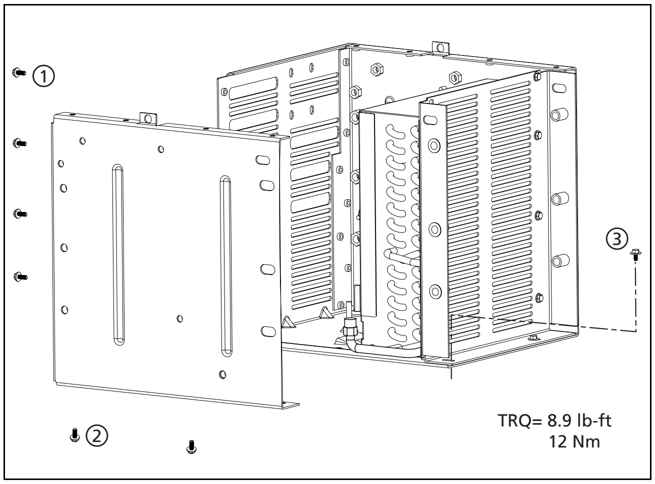


Figure 32. Side panel removal

7.4 Compressor Replacement

Replace the compressor only after all other possible causes for compressor malfunction have been ruled out according to the troubleshooting procedures under Section 4 and Section 5.

Before beginning work, read information under Section 6 "Compressor Replacement and System Service".

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Recover refrigerant and remove charging unit according to instructions under Section 7.2.
3. Remove side panel according to instructions under Section 7.3.
4. Remove protection cap on top of compressor.
5. Disconnect wiring. Refer to Fig. 22, on pg. 33 when reconnecting wires after compressor replacement.

Figure 33. 120 VAC connections

6. Disconnect refrigerant lines from compressor.
7. Disconnect compressor discharge line at condenser. Protect open lines with plastic caps or wrap to prevent the ingress of moisture and contaminates.
8. Remove the 2 hex-nuts of the bracket securing the compressor to the back-wall of the enclosure. See Fig. 34.
9. Remove the 3 hex-nuts holding the compressor to the enclosure base. See Fig. 35.

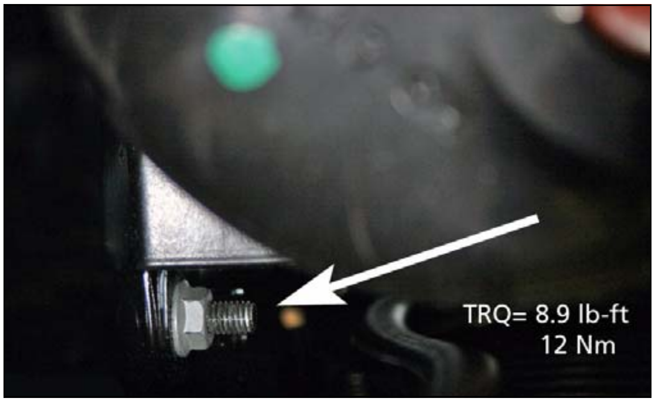


Figure 34. Compressor bracket to side panel mounting (2)

Figure 35. Compressor to base mounting (3)

10. Remove compressor.
11. Inspect compressor for possible contamination by dirt, water, etc. If contaminated, service system according to the recommendations under Section 6.1 after replacing the compressor.
12. Install new compressor in reverse order of removal.
13. Inspect all sealing surfaces of refrigerant lines and components for nicks and damage. Replace any damaged lines, fittings, seals or O-rings.
14. Replace refrigerant filter where required and service system according to the recommendations under Section 5.2.8 and Section 5.2.9.

Critical torque values:

Compressor outlet fitting	**43 Nm (32 lb-ft)**
Condenser inlet fitting	**43 Nm (32 lb-ft)**

7.5 Condenser Replacement

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Recover refrigerant and remove charging unit according to instructions under Section 7.2.
3. Remove side panel according to instructions under Section 7.3.
4. Disconnect refrigerant lines at condenser inlet/outlet. Protect open lines with plastic caps or wrap to prevent the ingress of moisture and contaminates.
5. Remove the front lower hex-bolt securing the front grille to the base. See Fig. 36.

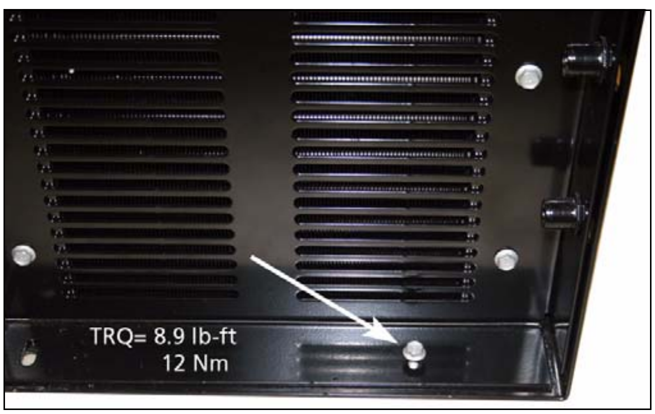


Figure 36. Condenser asssembly

6. Remove the hex-bolts holding the electrical harness to the fan shroud.
7. Loosen the two hex-nuts securing the fan shroud to the base and slide condenser / fan assembly forward and out. See Fig. 37

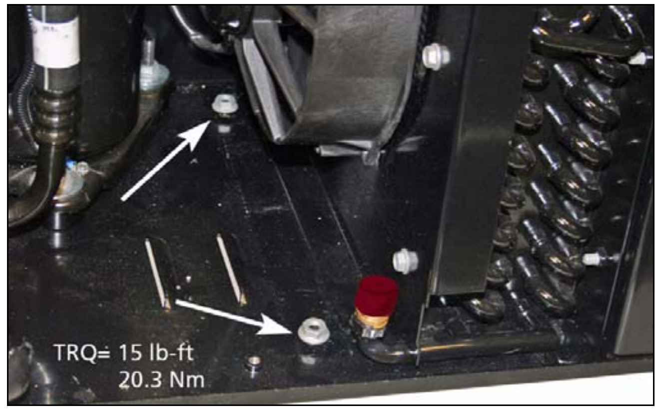


Figure 37. Fan shroud to base hex-nuts

8. Place on bench for further disassembly and component replacement.
9. Inspect condenser for possible contamination by dirt, water, etc. If contaminated, service system according to the recommendations under Section 6.1 after replacing the condenser.
10. Install new condenser in reverse order of removal.
11. Inspect all sealing surfaces of refrigerant lines and components for nicks and damage. Replace any damaged lines, fittings, seals or O-rings.
12. Replace refrigerant filter where required and service system according to the recommendations under Section 5.2.8 and Section 5.2.9.

7.6 Condenser Fan Replacement

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove charging unit housing top panel.
3. Remove side panel according to instructions under Section 7.3.
4. Remove left side fairings of vehicle if applicable.
5. Disconnect the fan electrical connector.
6. Remove the four hex-bolts securing the fan to the condenser shroud. See Fig. 38.

Figure 38. Hex-bolts securing condenser fan to shroud

7. Lift the fan assembly up and out.
8. Reassembly in reverse order of removal.
9. Perform system checks to ensure proper operation.

7.7 Low or High Pressure Switch Replacement

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove refrigeration unit cover.

NOTE: Refrigerant recovery is not required when replacing the pressure switches. A schrader valve under the switch will seat to close port during removal.

3. Disconnect switch electrical harness at connector.
4. Remove switch.
5. Install the replacement switch.
6. Torque to specification. 9.5 lb-ft (12.8 Nm)
7. Service refrigerant system as necessary in the event of refrigerant loss and to confirm correct fill.
8. Assemble remaining components in reverse order.

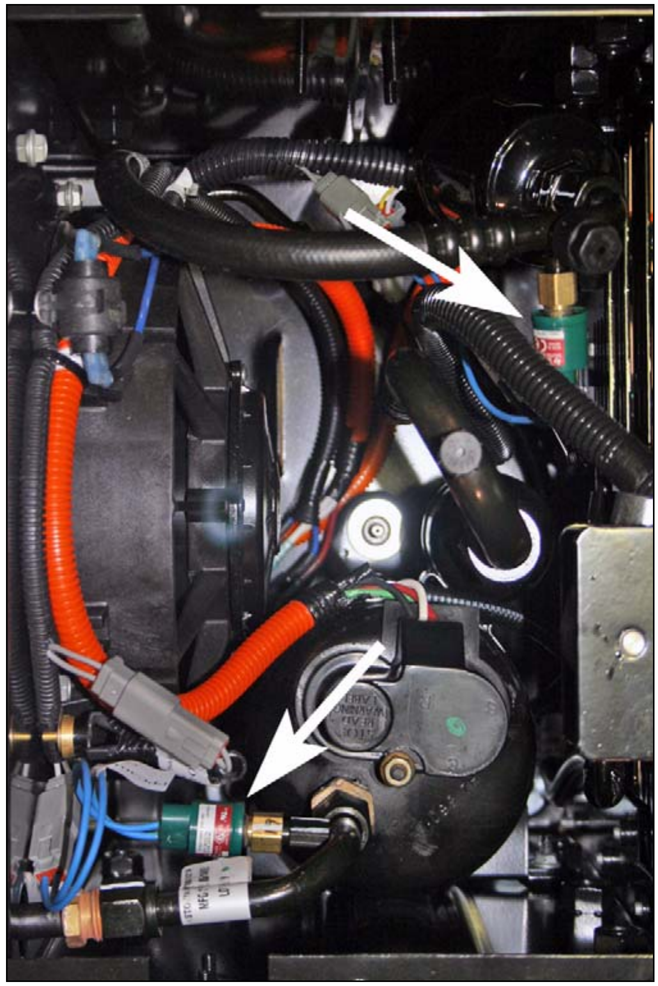


Figure 39. Pressure switches

7.8 Ambient Temperature Switch Replacement

1. Remove refrigeration unit cover.
2. Locate the ambient temperature switch. Refer to Fig. 40.
3. Replace as required.
4. Perform system checks to ensure proper operation.

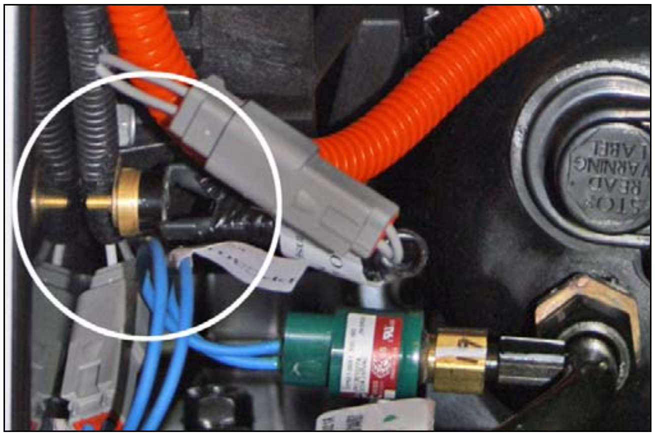


Figure 40. Ambient temperature switch

7.9 Refrigerant Bypass Valve Replacement

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove charging unit housing top panel.
3. Recover refrigerant.
4. Disconnect refrigerant lines at valve.

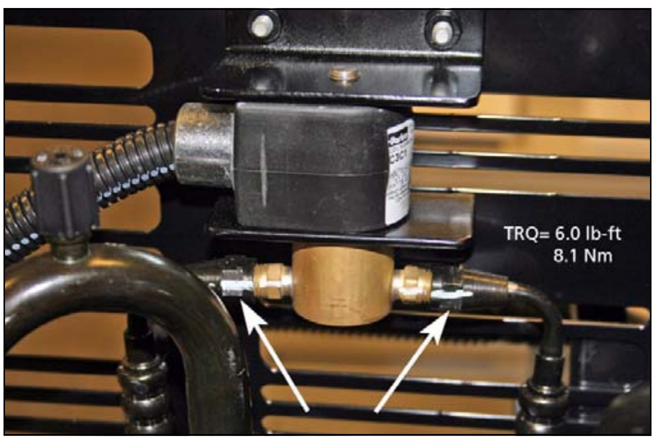


Figure 41. Bypass valve - refrigerant lines

5. Remove four hex-bolts securing the valve assembly to the rear panel. See Fig. 42.

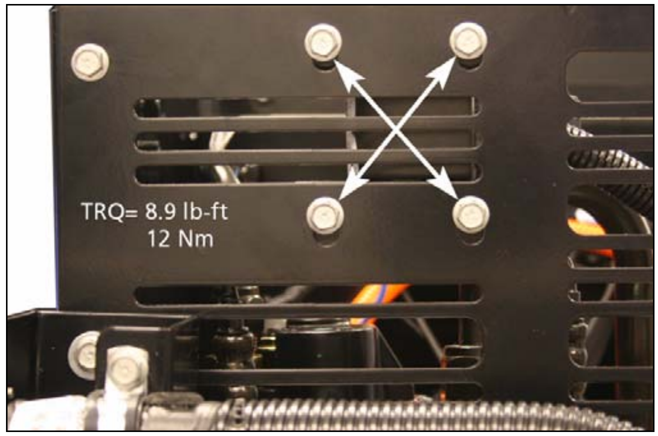


Figure 42. Bypass valve - mounting hex-bolts

6. Dissasemble and replace defective parts.
7. Inspect all sealing surfaces of refrigerant lines and components for nicks and damage. Replace any damaged lines, fittings, seals or O-rings.
8. Torque lines to specification.
   6.0 lb-ft / 72 lb-in (8.1 Nm)
9. Reassemble and install in reverse order.
10. Service system according to the recommendations under Section 5.2.8 and Section 5.2.9.

8. Component Replacement - Large Pallet Assembly

8.1 Thermal Expansion Valve (TXV) Replacement

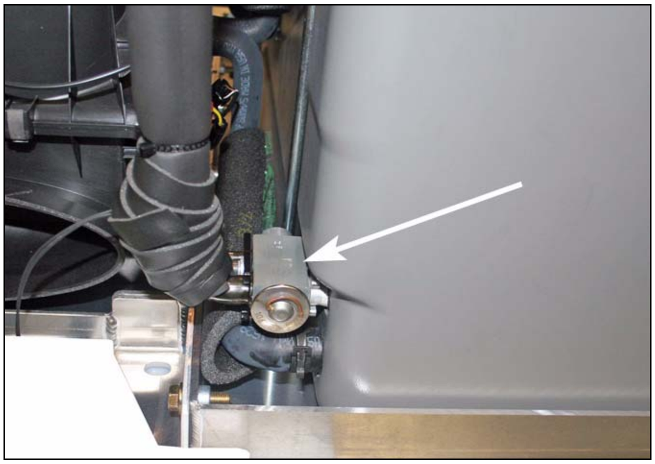


Figure 43. Thermal Expansion Valve

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove charging unit housing top panel.
3. Recover refrigerant.
4. Remove the allen head bolt securing the refrigerant lines to the TXV.
5. Pull refrigerant lines free. Protect open lines with plastic caps or wrap to prevent the ingress of moisture and contaminates.
6. Remove the 2 allen head bolts securing the TXV to the storage core pipes.
7. Pull the TXV free of the storage core pipes.
8. Inspect TXV and lines for possible contamination by dirt, water, etc. If contaminated, purge evaporator using purging equipment designed for R134a systems before installing the new TXV.
9. Before installing the new TXV and O-rings, inspect the storage core pipes and refrigerant lines for any burs. Clean up with fine emory or crocus cloth.
10. Coat storage core pipes and new O-rings with POE oil and place O-rings on storage core pipes.
11. Install new TXV in reverse order of removal.
12. Torque to specification. 12.5 lb-ft (17 Nm)
13. Coat refrigerant line ends and new O-rings with POE oil and connect to TXV.
14. Continue reassembly in reverse order of removal
15. Service system according to the recommendations under Section 5.2.8 and Section 5.2.9.

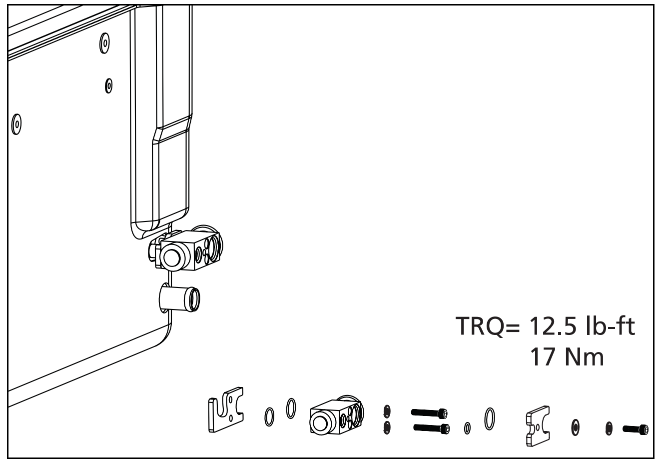


Figure 44. Parts sequence - thermal expansion valve

8.2 Storage Cooler Control Unit Replacement

Figure 45. Storage Cooler Control Unit (SCCU)

NOTE: Individual items of the SCCU can be replaced without removal of the SCCU housing or complete replacement of the SCCU assembly.

To replace defective components of the SCCU:

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Remove SCCU cover.
3. Locate defective item. A legend of the contents is provided under the cover.
4. After replacement of the defective item, perform a complete system check to ensure proper operation.

To replace complete SCCU assembly:

1. Disable 120 VAC power according to instructions under Section 7.1.
2. Disconnect all connectors, cut wire ties and unscrew P-clips where necessary.
3. Remove four screws securing SCCU to top of storage cooler assembly.
4. Remove and replace SCCU assembly.
5. After replacement of the SCCU assembly, perform a complete system check to ensure proper operation.

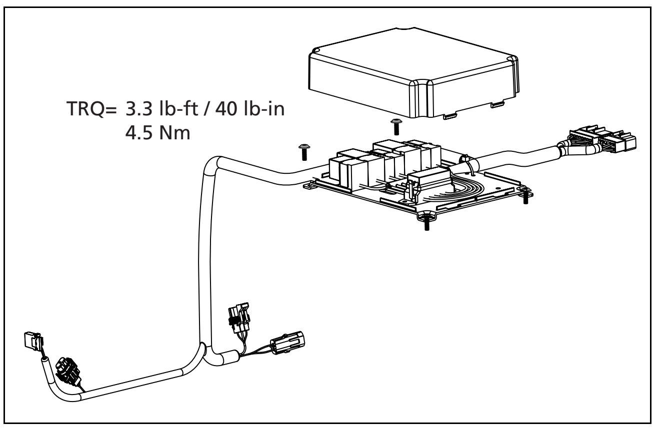


Figure 46. Storage Cooler Control Unit - complete

8.3 Coolant Circulation Pump Replacement

CAUTION: UNDER NO CIRCUMSTANCES SHOULD PURE WATER BE ALLOWED TO ENTER THE COOLANT CIRCUIT.

Allowing water to enter the system will lead to ice formation in the storage cooler and possibly damaging internal components. ALWAYS purchase and use a 50/50 premixed glycol based antifreeze where possible. If a premixed antifreeze is not available, a pure antifreeze mixed with water at a 50/50 ratio may be used as long as it is premixed BEFORE filling the system. DO NOT rely on the coolant circulation system to mix water and antifreeze.

1. Drain the coolant from the system according to...
   >>>> NEED TO DEFINE DRAIN PROCEDURE<<<<
2. Disconnect pump electrical connector.
3. Using spring clamp pliers, slide hose spring clamps off of pump barbs.
4. Remove two screws securing pump to storage cooler assembly, pull pump free and twist off hoses.
5. Install new pump in reverse order of removal.
6. Refill system to proper level with 50/50 antifreeze, water mixture.
7. Run coolant pump 10 minutes to purge air from system. Inspect coolant circuit for leaks. Top up reservoir to correct level as necessary.

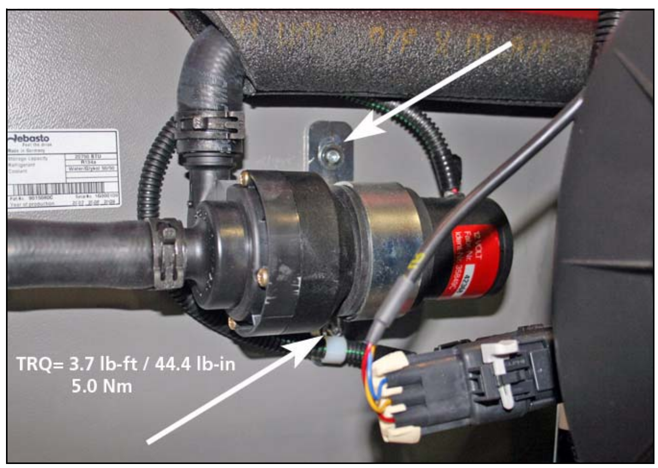


Figure 47. Coolant circulation pump mounting

9. Component Replacement - Small Pallet Assembly

9.1 Air Handler Assembly Removal

When required, the air handler can be removed for disassemble on a bench. In most cases, removal is not necessary for individual component replacement.

Removal

1. Remove air ducts to free air handler assembly for access and removal.
2. Drain the coolant from the system according to... **>>>> NEED TO DEFINE DRAIN PROCEDURE<<<<**
3. Using spring clamp pliers, slide hose spring clamps off of heat exchanger tubes.
4. Disconnect cabin air temperature sensor connector, mode door motor connector and blower motor connector from control harness.
5. Remove the four hex-nuts securing the air handler to the pallet.
6. Lift air handler up and out while carefully working hoses off of heat exchanger tubes.
7. Place on bench for further disassembly if required.

Individual Component Replacement

Refer to Fig. 48 for a complete break-down of parts and their relationship with the assembly.

Refer to the Torque Values Table starting on page 51 for fastener and component torque specifications.

Legend

1. Cover - Air filter housing and filter
2. Foam tape - Recirculated air inlet
3. Housing - upper
4. Sensor - Cabin air temperature (Recirculated)
5. Motor - Mode door actuator (Fresh/Recirculated)
6. Door - Fresh air / recirculated mode selection
7. Grommets (2 total)
8. Clips (9 total)
9. Foam tape - Fresh air inlet
10. Housing - lower
11. Hex-nut - Air handler to pallet (4 total)
12. Support - Wiring harness (2 total)
13. Pallet - Small
14. Air filter
15. Cap - Access to heat-exchanger bleeder valve
16. Heat exchanger
17. Fan and motor
18. Foam tape - Conditioned air outlet
19. Scroll cover
20. Adapter harness with diode
21. Seal - Pallet (2 total)

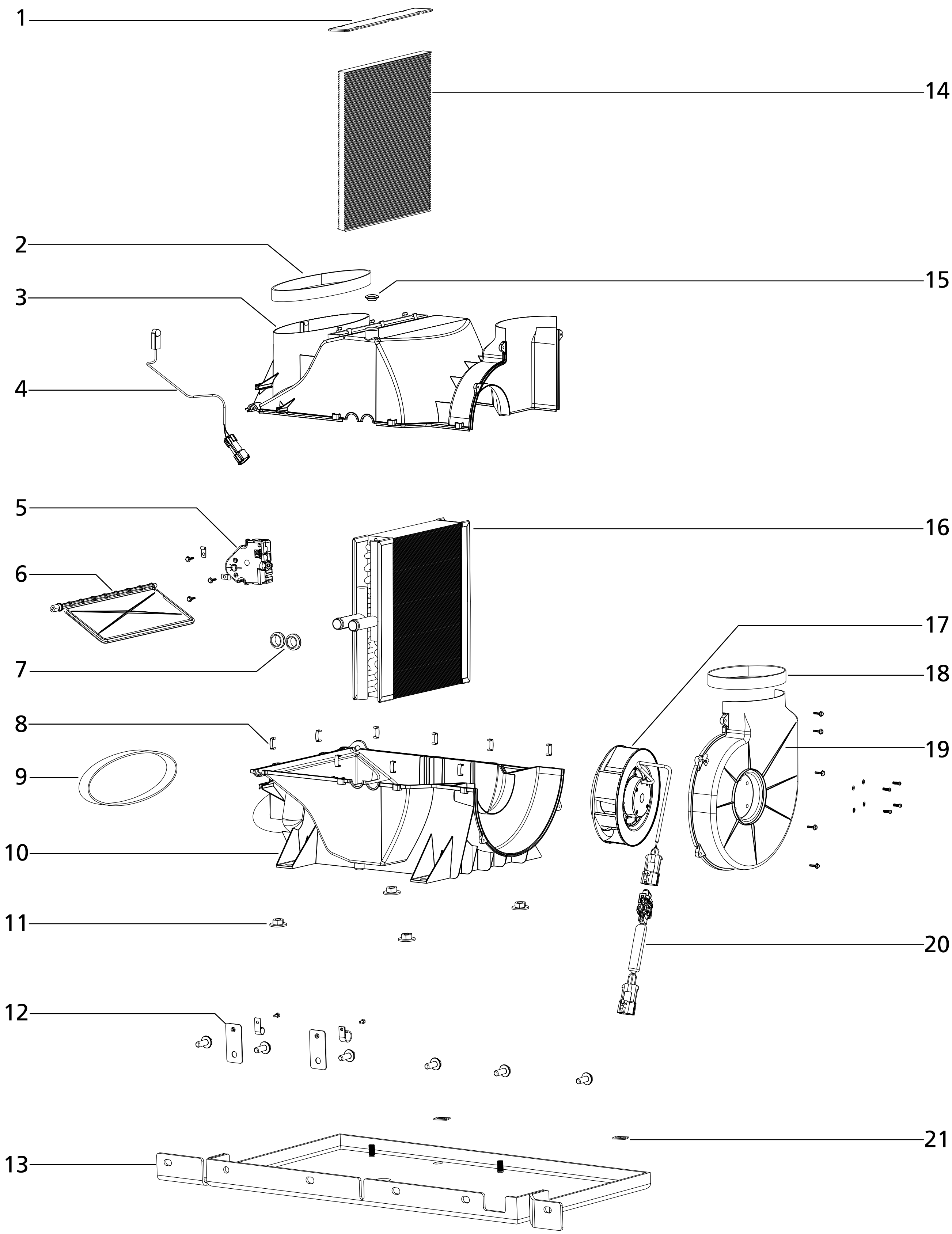


Figure 48. Air Handler Assembly - Exploded View

10. Technical Data

10.1 General Information

Unless tolerances are shown within the technical data table, a tolerance of ± 10% applies at an ambient temperature of +20°C (+68°F) and at the rated voltage and conditions.

10.1.1 Technical Data of the Storage Cooler Assembly

Storage Cooler Assembly	Specifications
Thermal Storage (storage A/C)	20,750 Btu (6.08 kWh)
Storage System Design	Maintenance free with patented graphite matrix (no additional batteries required)
Storage Cooler Assembly Dimensions	L 38.8" x W/D 22.3" x H 13.3" (986 x 566 x 338 mm)
Storage Cooler Assembly Weight (Wet)	200 lb. (90.7 kg) - Target

Table 7. Technical Data - Storage Cooler Assembly

10.1.2 Technical Data of the Air Handler Unit

Air Handler Unit	Specifications
Power Consumption of Fan Motor	225... 320 mA @ 2 Volts Maximum: 2.5... 3.7 Amps @ 12 Volts Nominal: 2.8... 3.2 Amps @ 12 Volts
Air Flow at Maximum Setting	140 cfm (237.9m^3/h)
Cooling Output	1,000 - 6,000 Btu/hr (0.30 - 1.75 kW)
Air Handler Dimensions	L 20.6" x W/D 14.3" x H 13.1" (522 x 363 x 333 mm)
Air Handler Weight	15 lb. (6.8 kg) - Target
Noise	<63 db (A)
Temperature Operating environment temperature Sleeper temperature control range	 50... 110°F (10... 43.3°C) 68... 78°F (20... 25.5°C)

Table 8. Technical Data - Air Handler Unit

10.1.3 Technical Data of the Charging Unit

Charging Unit	Specifications
Refrigerant Circuit **- Refrigerant Type** **- Refrigerant Charge Capacity** **- Refrigerant Oil** **- Refrigerant Oil Capacity**	 R134aUV (with UV leak detection capability) 2.3 lb. (1.04 kg) POE Oil (Polyol Ester) R134a compatible 12 oz. (354.8 ml.)
Compressor **-Refrigerating Capacity** **- Rated Voltage** **- Maximum Continuous Current**	 8,600 BTU/hr (2.52 kW) at 95°F (35°C) 103.5-120 VAC Not to exceed 8 amps AC.
Condenser Fan **- Rated Voltage** **- Maximum Continuous Current**	 12 VDC 10 amps DC
Charging Unit Dimensions	L 14.1" x W/D 16.9" x H 16.7" (359 x 430 x 425 mm)
Charging Unit Weight	100 lb. (45.4 kg)

Table 9. Technical Data - Charging Unit

10.2 Torque Values Table

Torque tolerance +/-1.0 lb-ft. (1.35 Nm)

DESCRIPTION - Refrigerant Connections	TORQUE VALUE
LOW PRESSURE SIDE HOSE TO COMPRESSOR INLET	32 lb-ft (43.4 Nm)
COMPRESSOR OUTLET HOSE AT COMPRESSOR	32 lb-ft (43.4 Nm)
COMPRESSOR OUTLET TO CONDENSER INLET	32 lb-ft (43.4 Nm)
CONDENSER OUTLET	32 lb-ft (43.4 Nm)
CONDENSER OUTLET HOSE TO FILTER / DRIER INLET	30 lb-ft (40.6 Nm)
FILTER / DRIER OUTLET TO QUICK CONNECT	30 lb-ft (40.6 Nm)
HIGH PRESSURE SIDE BYPASS HOSE TO MAGNETIC BYPASS VALVE FITTING (HIGH PRESSURE SIDE)	6.0 lb-ft / 72 lb-in (8.1 Nm)
LOW PRESSURE SIDE BYPASS HOSE TO MAGNETIC BYPASS VALVE (LOW PRESSURE SIDE)	6.0 lb-ft / 72 lb-in (8.1 Nm)
LOW PRESSURE SIDE BYPASS HOSE (from magnetic valve) TO LOW PRESSURE SIDE HOSE	32 lb-ft (43.4 Nm)
HIGH PRESSURE SIDE BYPASS HOSE (from magnetic valve) TO CONDENSER OUTLET HIGH PRESSURE SIDE HOSE	32 lb-ft (43.4 Nm)
BULKHEAD NUT - LOW PRESSURE QUICK CONNECT HOSE THROUGH-WALL FITTING	28 lb-ft (38 Nm)
LOW PRESSURE QUICK CONNECT HOSE TO THROUGH-WALL FITTING	32 lb-ft (43.4 Nm)
LOW PRESSURE SWITCH	9.5 lb-ft / 114 lb-in (12.8 Nm)
HIGH PRESSURE SWITCH	9.5 lb-ft / 114 lb-in (12.8 Nm)

DESCRIPTION - Fasteners	WHERE USED	TORQUE VALUE
#8 x 5/8" (HI-LO) SELF-THREADING SCREWS	AIR HANDLER HOUSING	1.8 lb-ft / 21.6 lb-in (2.4 Nm)
M4 PAN HEAD SCREWS	AIR HANDLER BLOWER FAN MOTOR	3.0 lb-ft / 36 lb-in (4.0 Nm)
M5 HEX SOCKET-HEAD SCREWS	STORAGE COOLER CONTROL UNIT (SCCU)	3.3 lb-ft / 40 lb-in (4.5 Nm)
M6 HEX SOCKET-HEAD SCREWS	COOLANT RESERVOIR AND COOLANT CIRCULATING PUMP	3.7 lb-ft / 44.4 lb-in (5.0 Nm)
M6 METRIC HEX-HEAD BOLTS	CONDENSER FAN SCREWS	3.7 lb-ft / 44.4 lb-in (5.0 Nm)
M6 HEX SOCKET CAP SCREWS	THERMAL EXPANSION VALVE (TXV)	12.5 lb-ft / 150 lb-in (17 Nm)
M6 METRIC HEX-HEAD BOLTS	GENERAL USE FOR SHEET METAL PANELS AND FIXTURES	8.9 lb-ft / 107 lb-in (12 Nm)
Continued on next page		

DESCRIPTION - Fasteners	WHERE USED	TORQUE VALUE
M6 METRIC HEX NUTS	GENERAL USE FOR SHEET METAL PANELS AND FIXTURES	8.9 lb-ft / 107 lb-in (12 Nm)
M8 METRIC HEX NUTS	COMPRESSOR AND CONDENSER TO FLOOR MOUNTING	15 lb-ft (20.3 Nm)
M10 METRIC HEX-HEAD BOLTS	COLD STORAGE CORE TO PALLET AND LARGE PALLET TO SMALL PALLET CONNECTION BOLTS	40.5 lb-ft (54.9 Nm)
M10 METRIC HEX NUTS	AIR HANDLER TO PALLET STUDS	40.5 lb-ft (54.9 Nm)
M10 METRIC HEX-HEAD BOLTS	FAIRING MOUNT STRUCTURE	28 lb-ft (37.9 Nm)
M10 NYLON INSERT HEX NUTS	FAIRING MOUNT STRUCTURE	28 lb-ft (37.9 Nm)

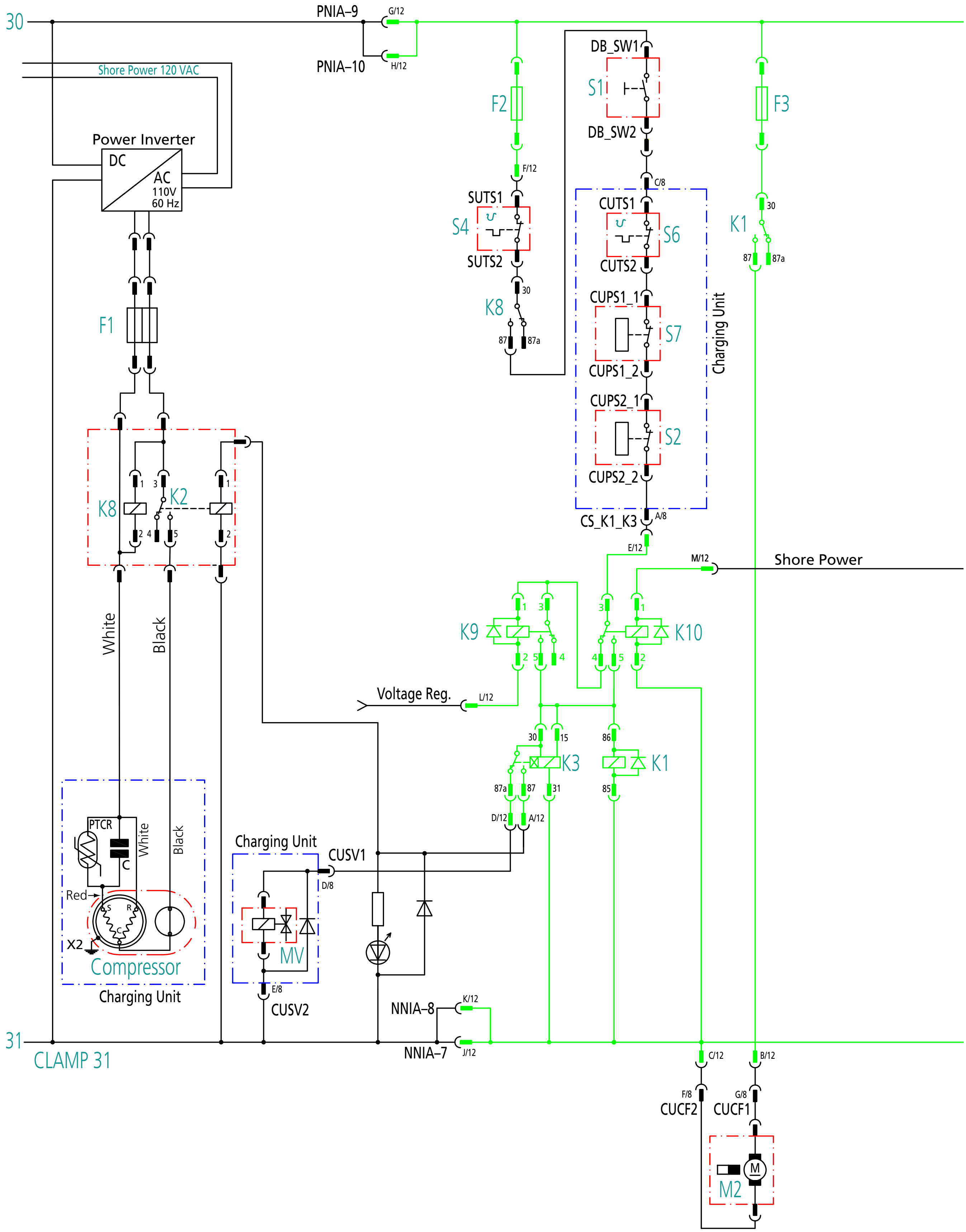
Torque values subject to revision. Torque tolerance +/-1.0 lb-ft. (1.35 Nm)

11. Circuit Diagrams

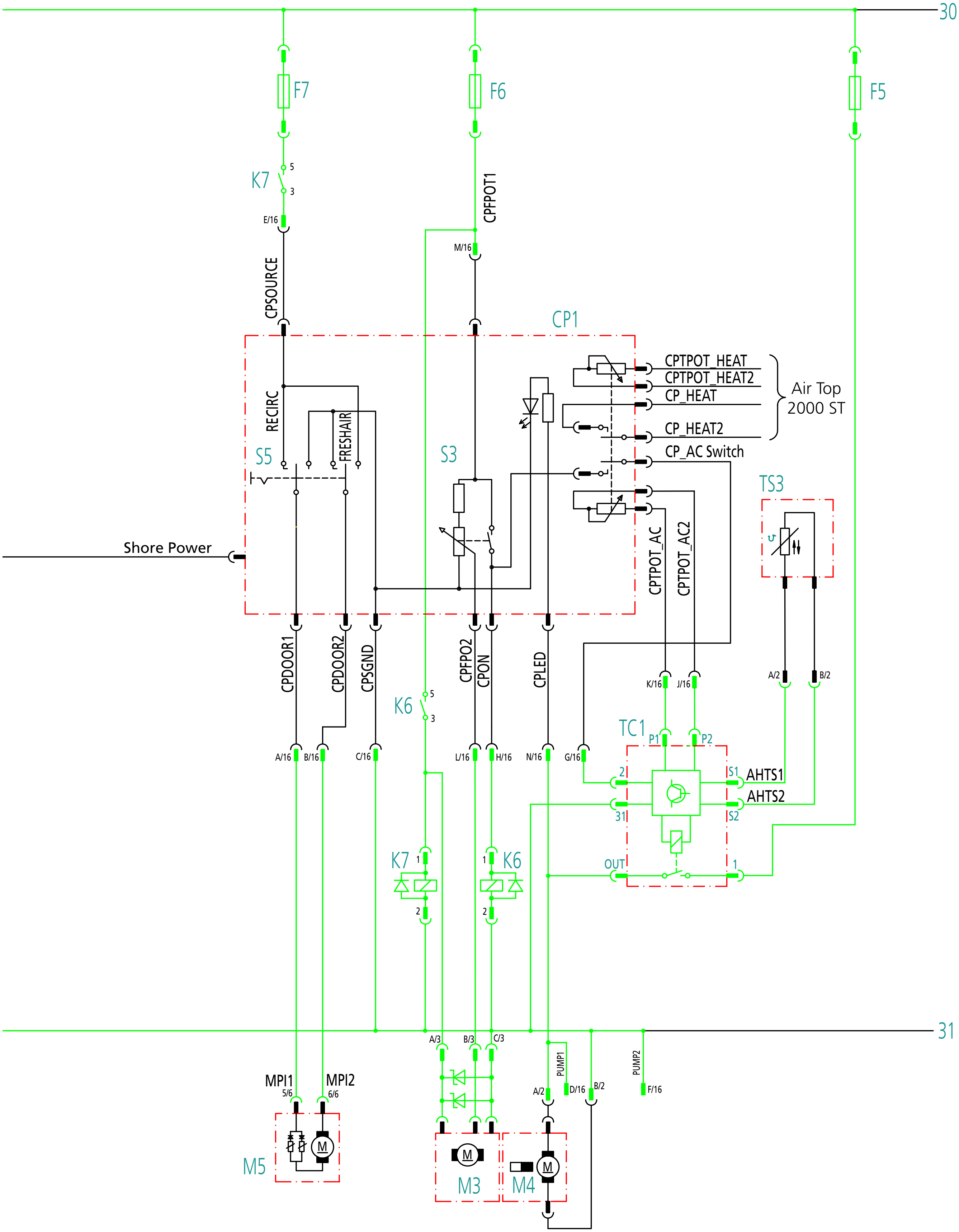
11.1 Legend

Position	Name	Function
CP1	Control Panel	PACCAR / Kenworth
C	Run Capacitor	Compressor Start Assist, Improve Power Factor
PTCR	Positive Temperature Coefficient Resistor	Compressor Start Assist
F1	Fuse 20A	2 Pole, 120 VAC - Compressor Motor
F2	Fuse 5A	Magnetic Bypass Valve, Compressor Control
F3	Fuse 20A	Condenser Fan
F5	Fuse 5A	Coolant Pump
F6	Fuse 5A	Blower Fan
F7	Fuse 2A	Fresh Air / Recirculation Mode Door Motor
K1	Relay	Condenser Fan Control
K2	Relay	Compressor Control
K3	Relay	Time Delay
K6	Relay	Quiescent Current
K7	Relay	Quiescent Current
K8	120 VAC Relay	120 VAC Monitor
K9	Relay	Voltage Regulator
K10	Relay	Shore Power
MV	Bypass Valve — R134a	Solenoid Valve Closed
M2	Motor	Condenser Fan
M3	Motor — Speed Controlled	Evaporator Blower
M4	Motor	Circulating Pump
M5	Motor	Recirc / Fresh Air Mode Door Actuator
S1	Switch	Charge Enable / Disable Dash Switch
S2	Switch	Low Refrigerant Pressure Cutout
S3	Switch	0... 10V analog — Control
S4	Thermostat	Storage Cooler Core Temperature
S5	Switch	Recirc / Fresh Air Mode Door Control
S6	Thermostat	Temperature Limiter — External Ambient
S7	Switch	High Refrigerant Pressure Cutout
TC1	Thermostat Module	Temperature Regulation
TS3	Thermostat	Temperature Sensor — Sleeper Compartment
X1	12 VDC 8-Pin Connector	Charging Unit Connection
X2	120 VAC 3-Pin Receptacle	Charging Unit Connection
X3	Compressor Casing Ground	120 VAC Ground

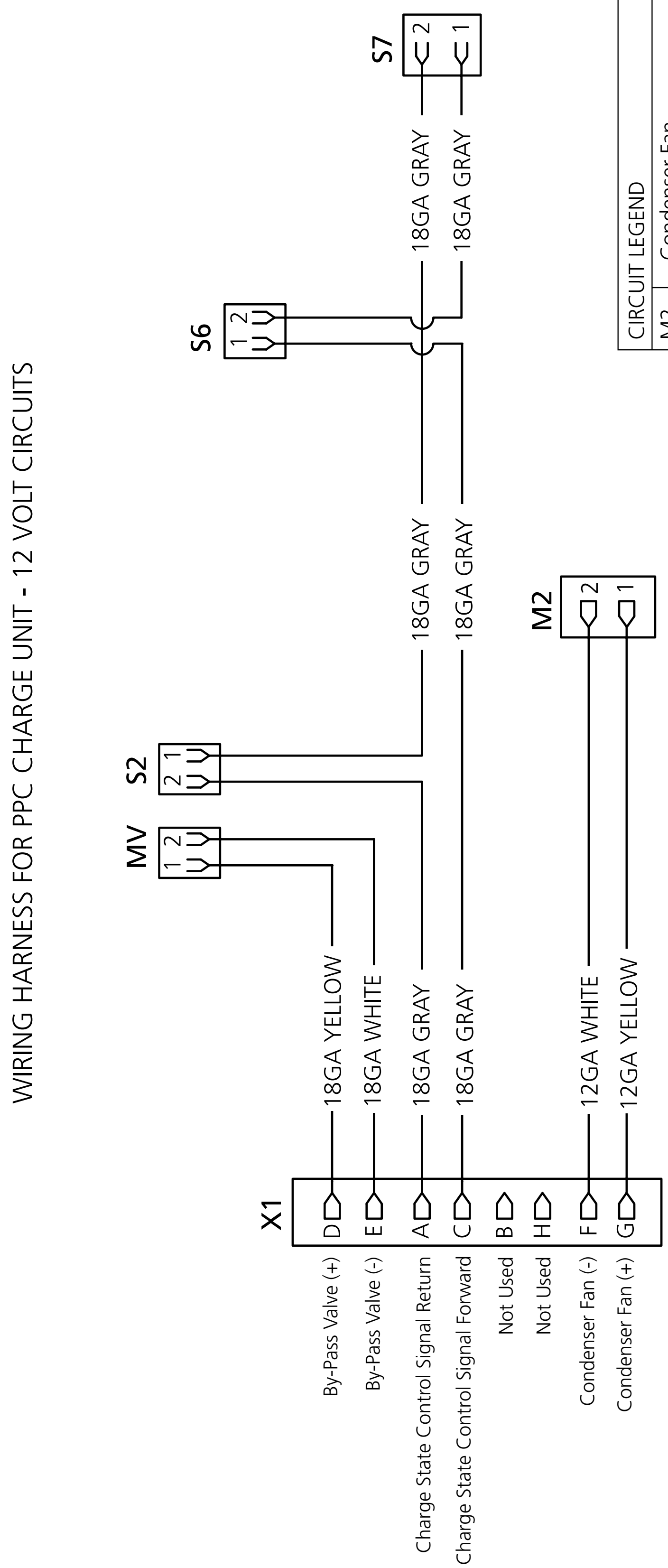
11.1.1 Control Schematic Part A (Continued on Next Page)



11.1.2 Control Schematic Part B (Continued on Previous Page)



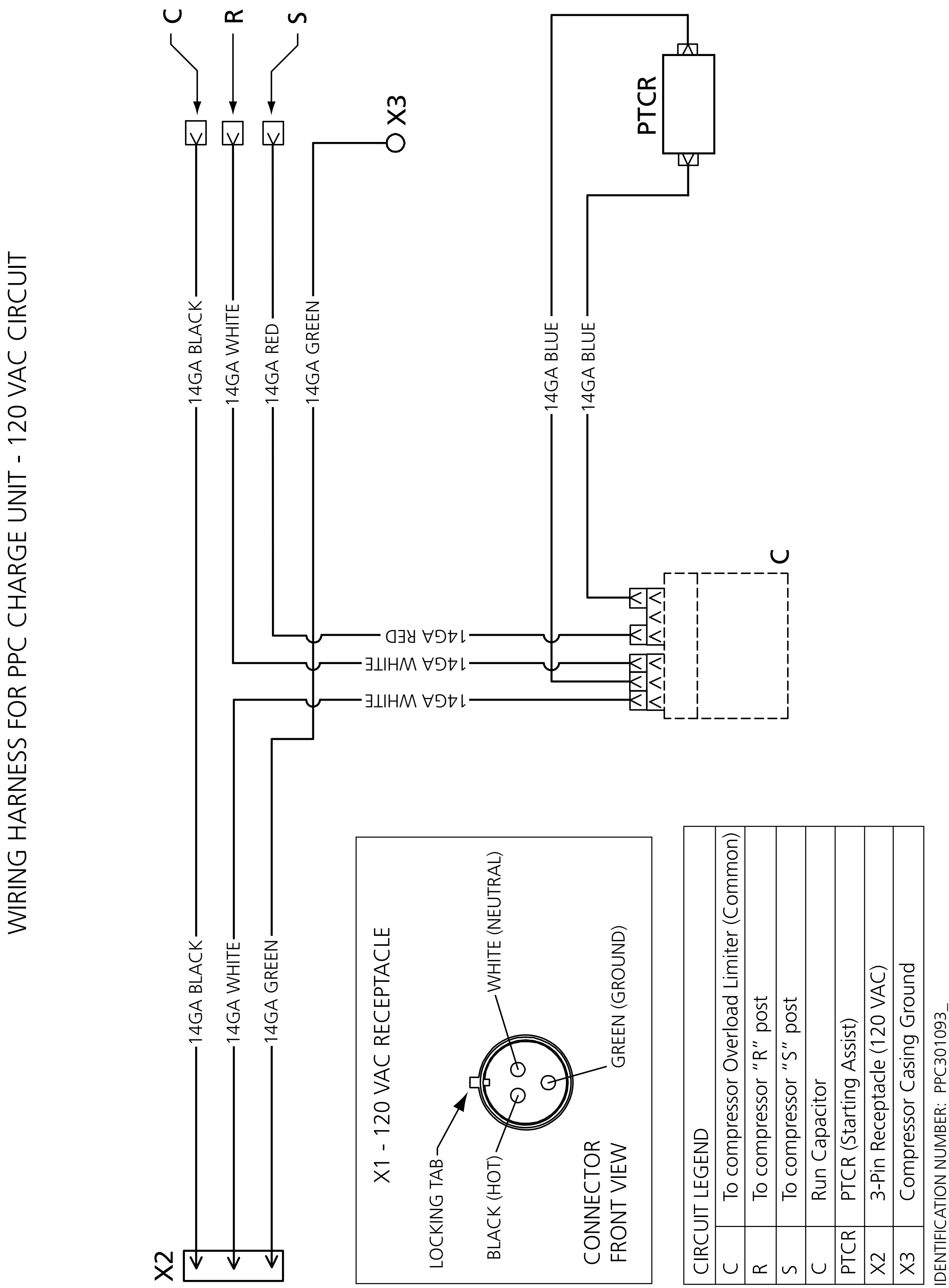
11.1.3 Charging Unit Wiring Harness - 12 VDC



CIRCUIT LEGEND	
M2	Condenser Fan
MV	By-pass Valve
S2	Low Pressure Switch
S6	Ambient Temperature Limiter
S7	High Pressure Switch
X1	8-Pin Connector

IDENTIFICATION NUMBER: PPC301026_

11.1.4 Charging Unit Wiring Harness - 120 VAC



CIRCUIT LEGEND	
C	To compressor Overload Limiter (Common)
R	To compressor "R" post
S	To compressor "S" post
C	Run Capacitor
PTCR	PTCR (Starting Assist)
X2	3-Pin Receptacle (120 VAC)
X3	Compressor Casing Ground

11.1.5 120 Volt AC Connections and System

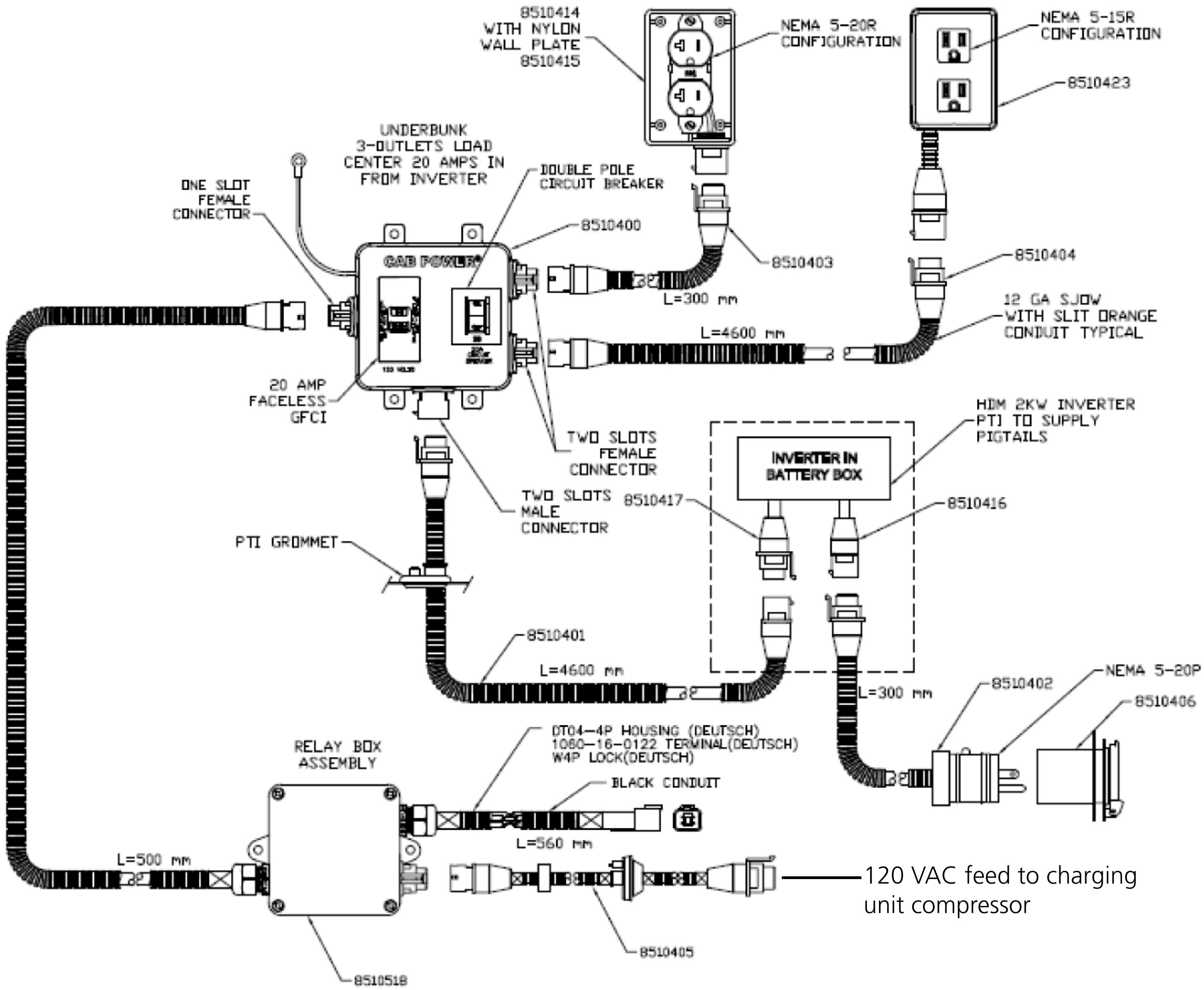


Figure 49. 120 VAC system

12. Appendices

12.1 5700 Series One-Shot™ Brass Couplings

12.1.1 Reconnecting Instructions

NOTE: The O-ring is only an intermediate seal during the initial connection of a pre-charged unit/line set combination. The O-ring is only used for sealing between the time the diaphragm is pierced and the final metal-to-metal seal is made.

The final leak-proof seal is a metal-to-metal connection made between the male and female coupling bodies.

1. Upon disconnection, remove O-ring and discard.
2. If O-ring is missing from groove, ensure O-ring is not lodged inside coupling halves and reconnect without O-ring.
3. Route the suction and or liquid lines in their original manner.
4. Remove any protector caps and plugs.
5. Carefully wipe coupling seats and threaded surfaces with a clean cloth to prevent the inclusion of dirt or any foreign material into the system.
6. Lubricate male half diaphragm and synthetic rubber seal with system-compatible refrigerant oil. Thread coupling halves together by hand to ensure proper mating of threads. Use proper size wrenches (on coupling body hex and on union nut) and tighten until coupling bodies seat or a definite resistance is felt.
7. Using a marker, make a line lengthwise from the coupling union nut to the bulkhead or bracket. Then tighten an additional 1/4 turn; the misalignment of the line will show the amount the coupling has been tightened. The final 1/4 turn is necessary to ensure the formation of a leak-proof joint.

If a torque wrench is used, the following torque values are recommended:

Coupling Size	Lb/Ft (N m)
-6	10-12 (13.5-16.3)
-10	35-45 (47.5-61)
-11	35-45 (47.5-61)
-12	55-65 (74.5-88)

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